California Instruments
A DIVISION OF
AMSTAR TECHNICAL PRODUCTS
COMPANY, INC.

Revision G
February 1981

INSTRUCTION MANUAL

MODEL 251T

AC POWER

SOURCE

Invertron

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LIST OF DRAWINGS

ASSEMBLY REFERENCE DESIGNATOR	DRAWING NUMBER	TITLE
None	C4025-900	OUTLINE DRAWING (Page 3)
	D4025-400	FINAL ASSEMBLY
A1 and A2	E4025-401	HEATSINK ASSEMBLY
A4	C4025-402	RANGE SWITCH ASSEMBLY
	E4025-070	SCHEMATIC, MAIN ASSEMBLY
A3	C4025-704	AMPLIFIER P.C. BOARD ASSEMBLY
	D4025-071	SCHEMATIC, AMPLIFIER BOARD
A6	C4050-702	METER P.C. BOARD ASSEMBLY
	B4050-072	SCHEMATIC, METER BOARD

SPECIFICATIONS

CALIFORNIA INSTRUMENTS MODEL 251T AC POWER SOURCE

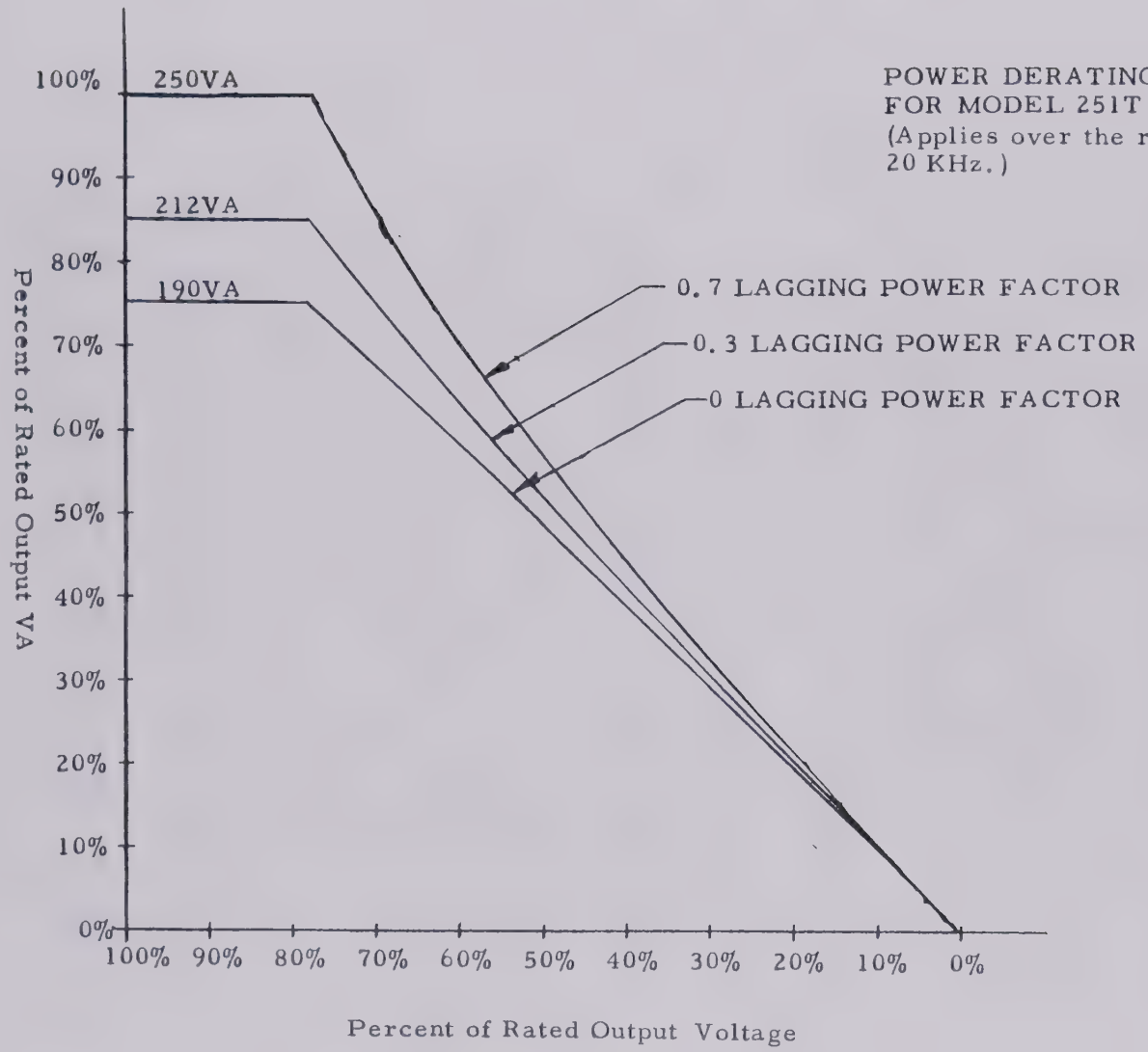
All specifications are tested in accordance with standard California Instruments test procedures and apply with a stable, low distortion input signal as generated by a T series plug-in oscillator.

POWER OUTPUT:	250 VA at 105 to 135 volts rms output from unity to ±0.7 power factor. See derating chart for operation at other output voltages and/or power factor.
OUTPUT VOLTAGE RANGES:	0 to 30 volts rms, 0 to 75 volts rms and 0 to 135 volts rms as determined by rear panel tap switch.
TOTAL HARMONIC DISTORTION:	Less than 0.30% distortion from 200 Hz to 1 KHz; less than .5% distortion from 45 Hz to 20 KHz.
AMPLITUDE STABILITY: (after one hour warm-up)	±0.25% for 24 hours at constant line, load and ambient temperature conditions.
LOAD REGULATION:	±1% over the range from 45 Hz to 5 KHz and ±2% over the range from 45 Hz to 20 KHz when tested at unity power factor. In addition, a load regulation adjustment permits the regulation to be adjusted to zero at any given line voltage, signal frequency and load conditions. Control resoltuion is 0.02%.
LINE REGULATION:	±0.25% of full output for a ±10% line change.
FULL POWER FREQUENCY RANGE: *	45 Hz to 20 KHz.
FREQUENCY RESPONSE:	±0.5 dB from 45 Hz to 20 KHz.
AC NOISE LEVEL:	80 dB below full output with input shorted; 70 dB below full output at full rated power output.
OVERLOAD AND SHORT CIRCUIT PROTECTION:	Complete protection from overloads and short circuits is provided. Automatic reset occurs when overload is removed.

* This power source may be used over the 20Hz to 40 KHz frequency range provided the output voltage and output VA are derated according to Table 2-2 in this instruction manual; otherwise, permanent damage to the unit may occur.

AMPLIFIER DRIVE REQUIREMENTS: (Normally obtained from plug-in)	5 volts rms (maximum) produces 135 volts rms.
AC INPUT LINE:	105 to 125 volts rms. Unit may be wired for the following single phase voltages on special order: 208 VAC, 220 VAC, 230 VAC and 240 VAC.
AC INPUT FREQUENCY:	48 to 65 Hz. (400 Hz available on special order.)
AC INPUT POWER:	950 watts maximum under worst case line and full rated load conditions.
OPERATING TEMPERATURE RANGE:	0 to 55°C.
FRONT PANEL METER: (Meter range also controlled by output voltage tap switch located on rear panel.)	0 to 40, 80, 160 volt AC voltmeter provides ± 1 per cent of full scale accuracy at 400 Hz and ± 3% of full scale accuracy over the range from 45 Hz to 20 KHz.
DIMENSIONS:	5 1/4" high x 19" wide x 21" deep.
NET WEIGHT:	60 lbs.
SHIPPING WEIGHT:	75 lbs.
FRONT PANEL FINISH:	Grey, 26440 per Federal Standard 595 with black silk-screened lettering.

POWER DERATING CHART
FOR MODEL 251T POWER SOURCE
(Applies over the range from 45 Hz to 20 KHz.)



GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments Model 251T Power Source. Detailed schematics, parts location drawings, calibration procedures and theory of operation are also contained for the aid of maintenance personnel.

1.2 GENERAL DESCRIPTION

The California Instruments Model 251T Power Amplifier is a solid state, high performance, low distortion power source that provides up to 250 VA output when used with the proper California Instruments oscillator. The Model 251T Power Source is illustrated in Figure 1-1. Full power output is available in three different voltage ranges and over the frequency range from 45 Hz to 20 KHz. These full power voltage ranges are:

1) 23.4 to 30 volts rms for servo motor and other low voltage applications,

2) 58.5 to 75 volts rms for applications where three phase 115 volt rms line-to-line power is required.

3) 105 to 135 volts rms for normal single phase 115 volt applications and for three phase 208 to 220 volt line-to-line applications.

For two phase and three phase operation, at least two power amplifiers must be combined together with the applicable multi-phase oscillator. Two power amplifiers will provide a total of 500 VA two phase power, or 500 VA of three phase power in the open delta configuration. Three power amplifiers will provide 750 VA of three phase power in the wye configuration.

1.3 ACCESSORY EQUIPMENT

The following accessories are available for use with the California Instruments Model 251 T Power Source.

1.3.1 California Instruments part number 4025-213 rack slides. These rack slides may be bolted directly to the sides of the unit, if required.

1.3.2 Model 1060-703 Extender Card. This card allows the pre-amplifier printed circuit board to be extended above the unit for service work.

1.3.3 Series 800T Variable Frequency Oscillators. These general purpose Wien bridge oscillators provide one phase, two phase or three phase outputs over the range from 20 Hz to 20 KHz in three bands. Units with single phase output are designated as 800T-20/20K-1-1ϕ, two phase oscillators are designated as 800T-20/20K-1-2ϕ and three phase oscillators are designated as 800T-20/20K-1-3ϕ. Calibration accuracy is ±1 per cent at 25°C and amplitude stability is 0.25 per cent per 24 hours at 25°C. The total harmonic distortion is less than 0.25 per cent from 20 Hz to 20 KHz.

1.3.4 Series 810T Fixed Frequency Oscillators. These oscillators provide one phase, two phase or three phase outputs over the range from 45 Hz to 10 KHz. Units with single phase output are designated as 810T-Freq-.1-1ϕ, two phase oscillators are designated as 810T-Freq-.1-2ϕ and three phase oscillators are designated as 810T-Freq-.1-3ϕ. Frequency accuracy is ±0.1 per cent at 25°C. Amplitude stability is ±0.01 per cent per 24 hours at 25°C and varies less than .0025 per cent per degree centigrade. Harmonic distortion is less than 0.1 per cent from 45 Hz to 5 KHz.

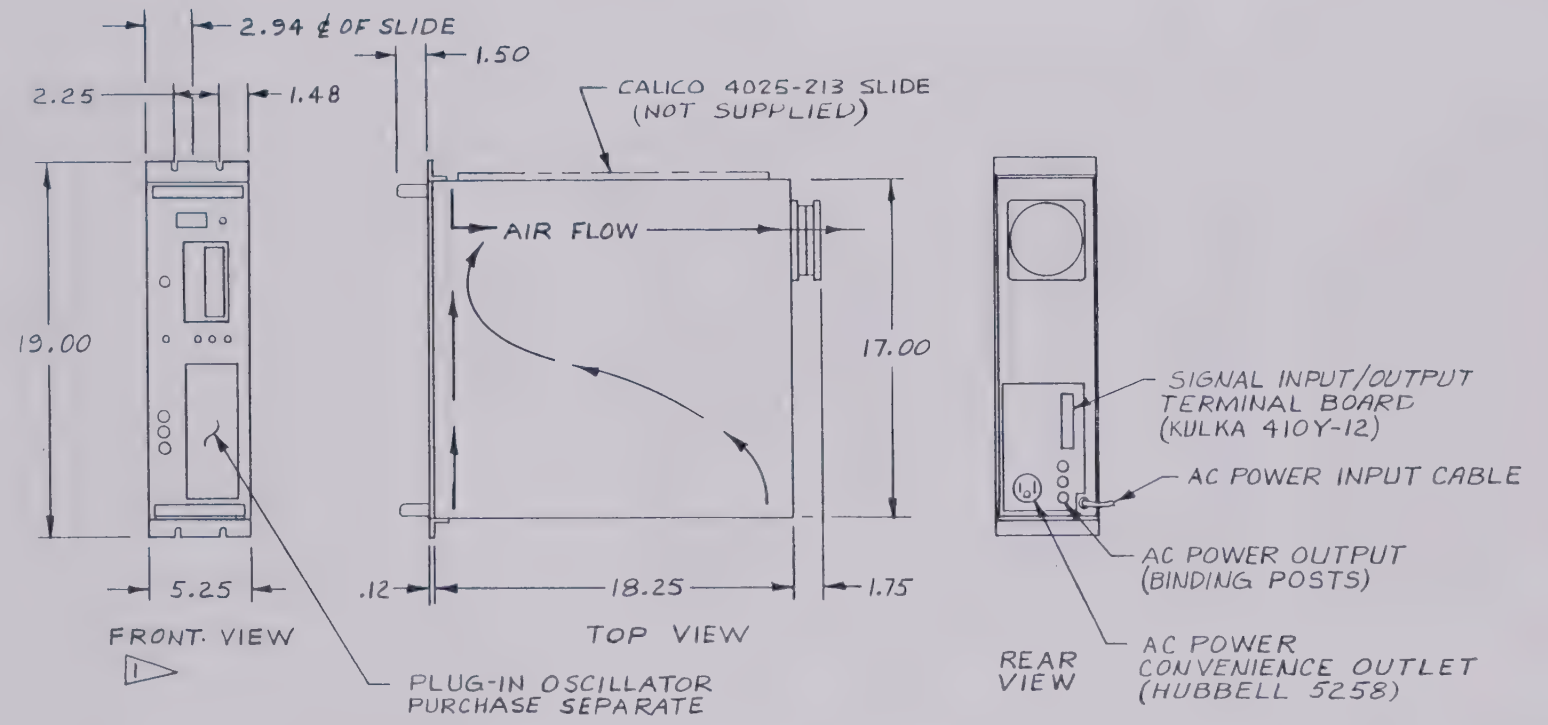
1.3.5 Series 815T Fixed Frequency Oscillators. These low-cost fixed frequency oscillators provide one phase, two phase or three phase outputs over the range from 45 Hz to 10 KHz. Units with single phase output are designated as 815T-Freq-.1-1ϕ, two phase oscillators are designated as 815T-Freq-.1-2ϕ and three phase oscillators are designated as 815T-Freq-.1-3ϕ. Frequency accuracy is ±0.1 per cent at 25°C. Amplitude stability is ±.25 per cent per 24 hours at 25°C and varies less than 0.02 per cent per degree centigrade. Harmonic distortion is less than 0.2 per cent from 45 Hz to 10 KHz.

1.3.6 Series 820T Fixed Frequency Crystal Oscillators. These oscillators provide one phase, two phase or three phase outputs over the range from 45 Hz to 20 KHz. Units with single phase output are designated as 820T-Freq-Accuracy-1ϕ, two phase oscillators are designated as 820T-Freq-Accuracy-2ϕ, and three phase oscillators are designated as 820T-Freq-Accuracy-3ϕ. Frequency accuracy is ±0.01 per cent or ±0.0001 per cent. Amplitude stability is ±0.25 per cent per 24 hours at 25°C. The total harmonic distortion is less than 0.15 per cent from 45 Hz to 5 KHz.

1.3.7 Series 830T Programmable Oscillators. These oscillators provide one phase, two phase or three phase outputs over the range from 45 Hz to 9.99 KHz. These units are packaged in a separate 5-1/4 inch package which may be mounted below/above the associated power amplifier.

1.3.8 Series 840T Programmable Oscillators. These plug-in oscillators provide one phase, two phase or three phase output at 380, 400 and 420 Hz. Frequency accuracy is ±0.1 per cent of programmed value. Servo feedback is taken from the output of each phase back to the 840T programmable plug-in oscillator and provides an accuracy of ±0.1 per cent of programmed value.

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	D.C.	SLIDE PN WAS ZERO C-3003-18			7/4/70	



C4025-900 A

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES XXX ± .010 XX = .03 X° - .30

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE C

TITLE: OUTLINE DRAWING, 250 VA POWER SOURCE

MODEL 251-T

RELEASE

CHECKER

DESIGN

DRFTSMN N Dunes 7/6/70

PURCHASING

PROJ ENGR

CHF ENGR

DASH NO | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH

CALICO
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

CONTRACT NO

CODE IDENT 16067

DWG NO C4025-900 REV 4

SCALE 1/4 SHEET 1 OF 1

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1 FRONT PANEL DIMENSIONS PER W.E./E.I.A. STD.

NOTES: (UNLESS OTHERWISE SPECIFIED)

WARNING

HIGH VOLTAGE (250 VAC)

Voltages up to 250 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

INSTALLATION AND OPERATION

2.1 UNPACKING

The California Instruments Model 251T Power Source is shipped in a cardboard container with protective inner packing. Do not destroy the packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

2.2.1 The Model 251T Power Source has been designed to operate from any one of the following AC line voltages, 115 volts, 208 volts, 220 volts, 230 volts or 240 volts rms. The power transformer is normally wired at the factory for operation from the 115 volt line. Table 2-1 below indicates how the primary connections to the power transformer are made for various AC input line voltages.

TABLE 2-1

NOTE

Prior to reconnection power transformer T1, remove all existing jumpers from the primary winding.

Nominal Input Voltage	Operating Line Voltage Range	Power Transformer Connections	Front Panel Circuit Breaker Value
115 volts rms	105-125 volts rms	jumper pins 1 and 3; jumper pins 2 and 6; connect load side of circuit breaker to pin 6.	10 ampere
208 volts rms	190-226 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 4.	6 ampere
220 volts rms	201-239 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 5.	6 ampere
230 volts rms	210-250 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 6.	6 ampere
240 volts rms	219-261 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 7.	6 ampere

2.2.2 The Model 251T has been designed to operate over the line frequency range from 48 to 65 Hz. On special order, units will be supplied to operate from the 400 Hz line.

2.2.3 The normal input power, at rated output, is between 575 and 950 watts depending on line and load conditions. During "turn-on" the peak transient will generally exceed 1500 watts.

2.3 CIRCUIT BREAKER REQUIREMENTS

The Model 251T Power Source uses a 10 ampere Heinemann AM12-10A curve 5 circuit breaker for operation from the 115 volt AC line. A Heinemann AM12-6A curve 5 circuit breaker is used for operation from the 208 volt through 240 volt AC lines. Substitution of circuit breaker type or current rating may cause permanent damage to the unit.

2.4 OUTPUT VOLTAGE AND METER RANGE

The output voltage range is determined by the three position rotary switch located at the rear of the Model 251T Power Source. This switch is also used to select the proper range for the front panel voltmeter. A front panel indicator lamp is used to indicate the position of this range switch.

2.5 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. If the unit appears in good condition, perform the following:

2.5.1 Connect the AC line cord to an AC power line of the proper voltage and frequency as determined by either the serial number tag on the unit or by inspection of the wiring to the primary of the power transformer (see Section 2.2 of this instruction manual). Connect a 3 KW Variac and a 3 KW wattmeter in series with the AC line. The Model 251T Power Source should draw less than 100 watts under no load conditions at mid-line voltage.

2.5.2 Using either a California Instruments 800T Series Oscillator or a suitable external low distortion sine wave oscillator, set the oscillator to the desired frequency (between 45 Hz and 20 KHz) and adjust the output of the oscillator to 5 volts rms. The amplifier input is available at pin 2 (tie oscillator ground to pin 1) of the small terminal strip TB1 located on the rear of the unit, if the external oscillator is employed. Tie a jumper strap from pin 2 to pin 3 of TB1 if an 800T Series Plug-in Oscillator is being used as the signal source.

2.5.3 Select the proper output voltage range as determined in Section 2.4 of this instruction manual. The following table lists the proper external load for full power output on each of the voltage ranges.

Output Voltage Range	Output Voltage	Full Power Load Resistance	50 Per Cent Power Load Resistance
0-30 volts rms	30 volts rms	3.6 ohms	7.2 ohms
0-75 volts rms	75 volts rms	22.4 ohms	44.8 ohms
0-135 volts rms	135 volts rms	73.0 ohms	146 ohms

2.5.4 Connect the proper 250 watt load resistor to the red and white binding posts on the rear of the power source. Connect a Tektronix Model 533A Oscilloscope or equivalent across this load resistor.

2.5.5 Using the GAIN control and the proper range on the front panel METER, set the output voltage to the rated voltage of the unit as determined in Section 2.5.3 of this manual. The power line wattmeter should read 600 to 700 watts at mid-line. Check on the oscilloscope for peak clipping or excessive distortion of the sine wave output.

2.5.6 With the output still adjusted as determined in 2.5.5, place a resistor in parallel with the external load resistor to provide a 50 per cent overload on the output of the power source, the value of this resistor is given in Section 2.5.3 of this manual. The signal on the oscilloscope should exhibit significant clipping on both the positive and negative peaks.

2.5.7 Remove the 50 per cent overload resistor and the output should automatically return to normal.

2.5.8 Place a short circuit in parallel with the external load resistor and then remove the short circuit after a few seconds. The signal on the oscilloscope should go to zero and then return to normal when the short circuit is removed. The front panel circuit breaker may be activated if the short circuit remains across the output for a period of time.

2.5.9 If it is desired to check the Model 251T Power Source on the other output transformer taps, select the desired range as described in Section 2.4 of this instruction manual and repeat steps 2.5.3 through 2.5.7 of this procedure.

2.5.10 The CALIBRATION PROCEDURE given in Section 4.0 of this manual should be followed if a more detailed evaluation of the unit is required at this time.

2.6 MECHANICAL INSTALLATION

The Model 251T Power Source has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with a pair of rack slides (California Instruments part number 4025-213).

The cooling fan on the rear of the unit must be free of any obstructions which would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the fans and the rear door of the mounting cabinet. Also, the air intake holes on the sides and rear of the power source must not be obstructed.

2.7 INPUT POWER WIRING

The Model 251T Power Source will operate from single phase input voltages from 105 volts to 260 volts rms in five ranges as described in Section 2.2 of this manual. The power source should be used with 115 volt power lines with a capacity of 10 amperes or greater. If 200 to 260 volt AC lines are used, their capacity should be 5 amperes or greater.

2.8 OUTPUT POWER WIRING

The power output wires should be large enough to avoid excessive line voltage drops. The front panel regulation control is capable of providing greater than 2 per cent over-regulation for all normal load conditions. If it is desired to provide a zero output impedance at the load side of the power wiring, it is necessary that these line drops be limited to approximately 1 to 2 per cent of the required output voltage. The following table lists the minimum acceptable wire size for a 1.0 per cent line drop assuming a 250 VA output at a distance of 20 feet from the power source to the load.

Output Voltage	Maximum Line Drop	Load Current	Loop Length	Minimum Required Wire Size
26 volts	.26 volts	9.6 amperes	40 ft.	#8
70 volts	.7 volts	3.58 amperes	40 ft.	#16
115 volts	1.15 volts	2.18 amperes	40 ft.	#21

The wire size should be reduced 3 sizes every time that the distance between the power source and load is doubled.

2.9 FRONT PANEL CONTROLS

2.9.1 The circuit breaker, located on the front panel of the Model 251T Power Source, is used to switch the POWER to the unit "on". At this time the amber indicator lamp located above this circuit breaker should glow.

2.9.2 The GAIN control is used to adjust the output voltage level of the power source. In the case of multi-phase power source, the gain control is turned nearly fully clockwise and then used as a fine gain trim control. The amplitude of the output of the multi-phase system is controlled by the amplitude control located on the multi-phase oscillator.

2.9.3 The REG control is recessed behind the front panel and is screw driver adjustable. This control is used to vary the output impedance of the power source. Turning this control in the clockwise direction reduces the output impedance of the power source. If this control is rotated far enough in the clockwise direction, the power source will exhibit a negative output impedance and may be used to compensate for line voltage drops between the output of the power source and the load. Section 2.8 includes additional information on the possible application of this control.

2.9.4 The RANGE lamps on the front panel indicate which output voltage range, 0 to 30 volts, 0 to 75 volts or 0 to 135 volts is activated by the rear panel RANGE switch. The corresponding voltmeter ranges are 0 to 40 volts, 0 to 80 volts and 0 to 160 volts full scale, respectively.

2.10 OPERATION OVER EXTENDED FREQUENCY RANGE

2.10.1 This power source must not be driven at signal frequencies below 20 Hz or above 40KHz, otherwise permanent damage to the unit may occur. For operation in the region between 20 Hz and 45 Hz and for operation in the region between 20 KHz and 40 KHz, derate the output voltage and output power according to Table 2-2 in order to provide reliable operation of the power source.

TABLE 2-2

Output Frequency	Maximum Safe Output Voltage			Maximum VA Output at Maximum Safe Output Voltage with ±0.7 Power Factor Load.
	30 Volt Range	75 Volt Range	135 Volt Range	
20 Hz	13.3V	33.3V	60V	125 VA
30 Hz	20 V	50V	90V	195 VA
40 Hz	26.7V	67V	120V	250 VA
45 Hz to 20 KHz	30V	75V	135V	250 VA
20 KHz to 30 KHz	30V	75V	135V	200 VA
30 KHz to 40 KHz	20V	50V	90V	155 VA

THEORY OF OPERATION

3.1 GENERAL

The California Instruments Model 251T Power Source is an all silicon solid state 250 VA amplifier and, with companion oscillator, is designed to provide reliable sine wave AC power over the frequency range from 45 Hz to 20 KHz.

A block diagram for the amplifier is shown in Figure 3-1. The pre-amplifier G1 is used to amplify the input signal to such a level so as to supply adequate drive to the power amplifier G2.

The power amplifier G2 provides the necessary sine wave signal to drive the output transformer T3. The output transformer has floating secondary windings which allow the load to float from the amplifier and oscillator circuitry.

The power amplifier G2 contains the overload and short circuit protection circuitry. A local negative feedback loop is taken from the output of the power amplifier back to the pre-amplifier, G1.

The overall negative feedback is taken from the primary of the output transformer back to one input of the pre-amplifier and provides a closed loop gain of 20 from the high side of A3R2 to the primary of T3.

The multiple secondary of transformer T3 is inner connected by means of the output voltage range switch A4S1. This switch also controls the front panel range lights and the range of the front panel voltmeter. A portion of the output load current is used to drive transformer T2. This transformer is connected so as to provide a positive feedback voltage proportional to the load current. As this positive feedback is increased from zero with potentiometer R5, the output impedance of the power source is reduced toward zero.

Power transformer T1, along with the associated rectifiers and filters, supply the operating voltages for the plug-in oscillator, the pre-amplifier G1 and the output amplifier G2.

3.2 DETAILED CIRCUIT DESCRIPTION

A schematic diagram for the Model 251T Power Source is shown in drawing E4025-070 with the exception that the circuitry contained on the pre-amplifier circuit board (assembly A3), the meter board (assembly A6) and the plug-in oscillator. A schematic for the pre-amplifier circuit board is given in drawing D4025-071 and a schematic for the meter circuit board is given in drawing B4050-072. For information on the

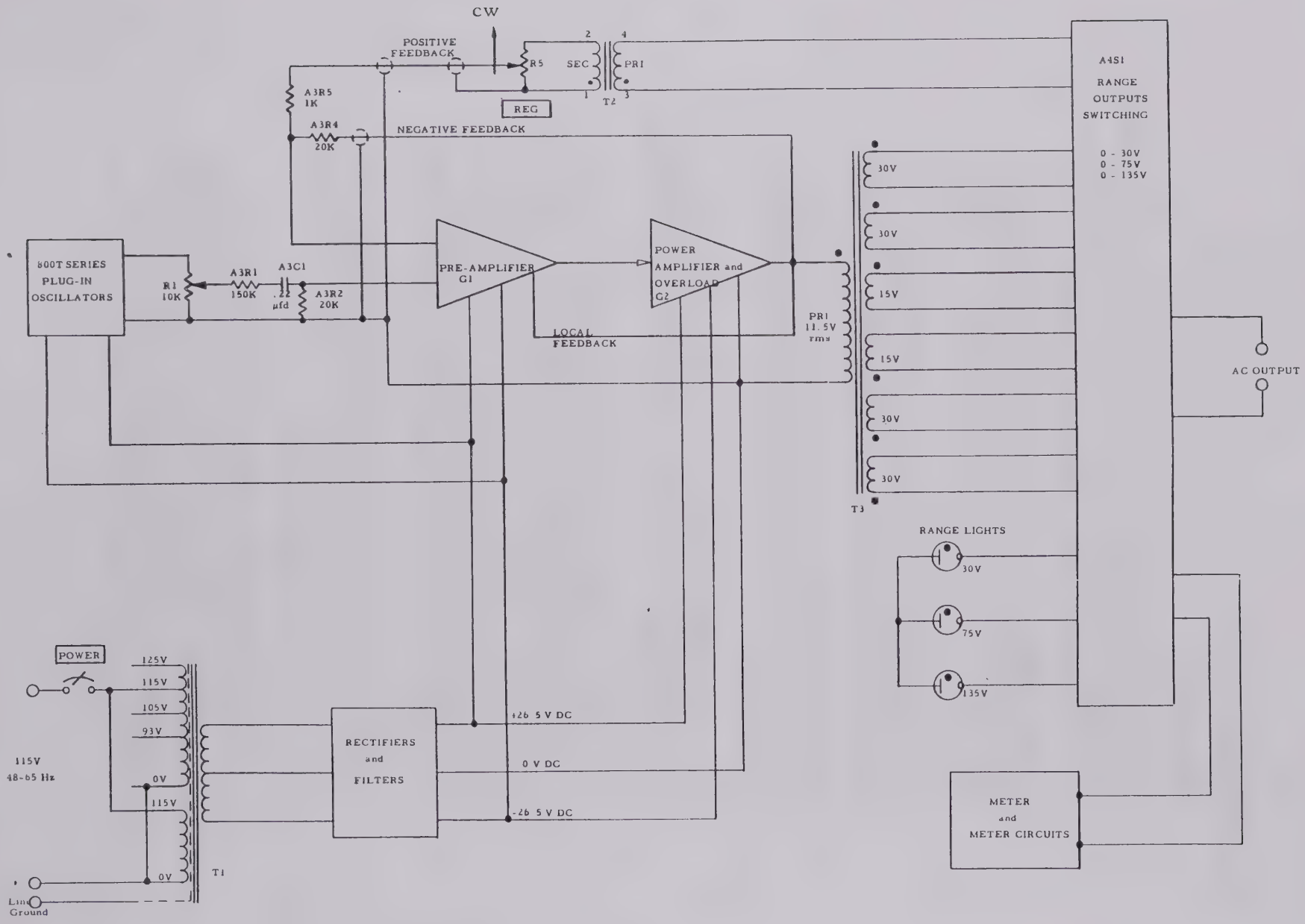


FIGURE 3-1. BLOCK DIAGRAM OF MODEL 251T POWER SOURCE

plug-in oscillator, consult the applicable oscillator manual. These drawings give typical voltage levels and wave forms for the various sections of the power source.

3.2.1 PRE-AMPLIFIER

The pre-amplifier G1 is a part of the A3 assembly and consists of transistors A3Q1 through A3Q6 and associated components connected as a direct coupled differential amplifier. The open loop gain of this pre-amplifier is approximately 45 at 400 Hz and rolls off at 6 db per octave above 30 KHz.

Transistor A3Q1 is a dual field effect transistor used in the differential source follower configuration to provide a high input impedance and a gain of approximately 1.0. Potentiometer A3R7 is used to adjust the DC bias at the primary of T3 to zero volts with no signal.

Transistor A3Q2 is a dual transistor used in a differential configuration and provides a gain of approximately 15 at 400 Hz. Capacitor A3C4 and resistor A3R15 provide a high frequency step roll off from 30 KHz to 200 KHz.

Transistor A3Q3 and associated components are connected as a constant current source which provides the emitter current for A3Q2. This current source is designed to sink 2 milliamperes from the junction of A3R10 and A3R11 to the -10 volt supply.

Transistors A3Q4, A3Q5 are used in the differential amplifier configuration and provide an open loop gain of 3 at 400 Hz.

Transistor A3Q6 and associated components are connected as a constant current source which provides 9 milliamperes to the junction of A3R16 and A3R17.

3.2.2 POWER AMPLIFIER

The power amplifier G2 mechanically consists of the remainder of the A3 board and the large heatsinks designated as the A1 and A2 assemblies. Electrically, the power amplifier consists of transistors A1Q1 through A1Q6, A2Q1 through A2Q6, and A3Q7 through A3Q10 and associated components.

Transistor A3Q7 and associated components are connected as a constant current source which provides up to 55 milliamperes to bias the output stage by means of diodes A3CR7 and A3CR8. This allows the output stage to operate as a Class A amplifier for no load or low VA load conditions and to operate nearly as a Class B amplifier for large load conditions.

Transistor A3Q8 and associated components are connected in the grounded emitter configuration. Local negative feedback is provided by A3C5, A3C6, A3R18 and A3R26. The local feedback limits the gain of this stage to 40 at 400 Hz. The gain falls off at 6 db per octave above 30 KHz.

The positive polarity output amplifier is contained on the A1 assembly and consists of A1Q1 through A1Q6 connected as emitter followers. These transistors supply a total of 40 amperes peak during the positive one-half cycle of the output wave form when the power source is loaded to 250 VA output at 78 per cent of rated output voltage (worst case condition within specification limits). These positive output amplifier transistors and their associated heatsink can dissipate over 250 watts with less than a 35°C case temperature rise with an air flow of 40 cfm per heatsink.

The negative polarity output amplifier is contained on the A2 assembly and consists of A2Q1 through A2Q6 connected in the quasi complementary symmetry configuration. These transistors supply a total of 40 amperes peak during the negative one-half cycle of the output wave form when the power source is loaded to 250 VA output at 78 per cent of rated output voltage (worst case condition within specification limits). These negative output amplifier transistors and their associated heatsinks can dissipate over 250 watts with less than a 35°C case temperature rise with an air flow of 40 cfm per heatsink.

When the power source is delivering its full rated output voltage, the primary of the output transformer has an 11.5 volt rms signal.

3.2.3 OVERLOAD PROTECTION

The overload protection circuitry is shown in drawing D4025-071 and consists of A3Q9, A3Q10 and associated components.

Transistor A3Q9 and associated components are connected as a clamp circuit which is used to protect the positive polarity output amplifier (assembly A1) during periods of overload or short circuit. This is accomplished by sensing the load current flowing through A1R2 and applying the resultant voltage drop to the emitter base junction of A3Q9 through a suitable attenuator network. During periods of overload, the emitter-base junction of A3Q9 is forward biased sufficiently to allow the collector circuit of A3Q9 to conduct a significant portion of the base drive normally available to A1Q1. This limits the base drive to A1Q1 and hence limits the available current from the positive polarity output amplifier during periods of overload. Potentiometer A3R43 is used to set the current level where the overload protection circuit is activated.

Transistor A3Q10 and associated components are used in a similar fashion to protect the negative polarity output amplifier (assembly A2). The only differences are that the control voltage for A3Q10 is sensed across R6 and potentiometer A3R44 is used to set the overload current level.

The rated VA output of the power source is, to a large extent, determined by the power dissipation in the quasi-complementary symmetry output stage. This power dissipation is determined by the power factor of the load, the output VA level of the amplifier, and to the actual output voltage expressed as a percentage of the rated output voltage. The derating chart, given in the specifications, expresses this derating in a graphical form.

The design of the overload circuitry is such that the overload level is determined by the same three parameters that determine the power dissipation in the Class B output stage. Resistors A3R34, A3R37, A3R38, A3R39, A3R41 and A3R42 have been selected so that the overload protection circuit and the power factor derating chart track one another quite closely in the region between 0 volts output and 78 per cent of rated output voltage. In the region between 78 per cent of rated output voltage and 100 per cent of rated output voltage, the rated VA output of the power source is limited by an arbitrary rating and as a result, the overload circuit allows a somewhat greater power output than that specified for the power source. The unit will be reliable in this mode of operation, however, output distortion and/or other specifications may be excessive.

Resistors A3R35, A3R36 and capacitors A3C9, A3C10 are selected at the factory so as to provide slightly reduced drive to the overload transistors A3Q9 and A3Q10 at high frequencies. This allows the 251T AC Power Source to provide rated power output without excessive distortion at 20KHz.

3.2.4 OVERALL NEGATIVE FEEDBACK

The overall negative feedback loop is a single-ended potentiometric feedback loop taken from the primary of T3 back to the gate of A3Q1B. The feedback network consists of A3R3, A3R4, A3R5, A3C2 and A3C3 and limits the mid band closed loop voltage gain of the amplifier to 20 from the gate of A3Q1A to the primary of T3.

This overall feedback loop provides approximately 40dB of negative feedback over the range from 45 Hz to 20 KHz. The feedback rolls off at approximately 9dB per octave for frequencies greater than 20 KHz. The purpose of this feedback loop is to insure that the frequency response, distortion, gain and amplitude stability specifications are met and/or exceeded.

3.2.5 POSITIVE CURRENT FEEDBACK

The positive current feedback loop generates a positive feedback voltage proportional to the load current in the secondary of T3. This is accomplished in the following fashion; the primary of T2 senses a portion of the load current depending on the output voltage range of the power source. This current is converted into a voltage at the secondary of T2. A portion of this voltage is developed across the arm of potentiometer R5 and is then added in series with the negative feedback signal applied to the gate of A3Q1B. Potentiometer R5, which is accessible from the front panel of the power source, is used to adjust the amount of positive feedback and, thereby, adjust the output impedance of the power source.

3.2.6 POWER SUPPLY

A schematic diagram for the DC power supply is a part of drawing E4025-070. This power supply delivers ±26.5 volts ±5 per cent at 10 amperes DC with less than 2 volts peak-to-peak ripple from the 115 volt 60 Hz AC line. These unregulated supplies consist of rectifier diodes CR1 through CR4 and filter capacitors C1 and C2 connected in a conventional fashion.

3.2.7 FRONT PANEL METER

The front panel meter M1 has a full scale sensitivity of 0 to 1 milliampere DC and an internal resistance of approximately 100 ohms. The meter has three scales with full scale ranges of 0 to 40 volts AC, 0 to 80 volts AC, and 0 to 160 volts AC. The meter rectifiers and scaling circuitry are mounted on the rear of the meter.

The meter circuitry is designated as the A6 assembly and is shown in drawing B4050-072. This circuitry consists of rectifier diodes A6CR1 through A6CR4, potentiometer A6R1 and associated components. The four rectifier diodes are connected so as to form a full wave bridge rectifier. Potentiometer A6R1 is used to shunt a small portion of the meter current and provide a sensitivity adjustment on the 40 volt scale. Resistors A6R4 and A6R5 are set at the factory to provide proper tracking on the 160 volt and 80 volt ranges, respectively.

The meter range is switched with the rear panel voltage range switch so that the 40 volt full scale range of the meter is used with the 0-30 volt range of the power source, the 80 volt full scale range of the meter is used with the 0 to 75 volt range of the power source, and the 160 volt full scale range of the meter is used with the 0 to 135 volt range of the power source.

3.2.8 VOLTAGE RANGE SWITCH

The voltage range switch is located on the rear panel of the power source and is designated as the A4 assembly. A schematic diagram for the range switch assembly is a part of drawing E4025-070.

The primary purpose of this voltage range switch is to interconnect the multiple secondary windings of T3 in various fashions depending on the desired output voltage range. The following table illustrates this interconnection.

TABLE 3-1

OUTPUT VOLTAGE RANGE	DESCRIPTION OF INTERCONNECTION
0 to 30 volts rms	S3 and S4 are connected in series aiding configuration which is in parallel with S1, S2, S5, S6; current transformer T2 is connected in S3, S4 circuit only.
0 to 75 volts rms	S1, S2 and S3 are connected in series aiding configurations; S4 S5 and S6 are connected in series aiding configuration; these two configuations are in parallel and current transformer T2 is connected in S4, S5, S6 circuit only.
0 to 135 volts rms	S3 and S4 are connected in parallel; S1, S2, S3, S5 and S6 are connected in series aiding configuration; current sense transformer T2 is connected in series with total load current.

WARNING

HIGH VOLTAGE (250 VAC)

Voltages up to 250 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

CALIBRATION PROCEDURE

4.1 GENERAL

The following calibration procedure, or any part of it, may be performed on a routine basis to insure that the Model 251T Power Source remains within specified tolerances. This procedure should always be performed after any repairs have been made to the unit. This procedure also covers test methods for the following power source adjustments and specifications:

a) Initial Adjustments

b) AC Line Input Power and Overload Adjustment

c) Voltage, Power Output, and Harmonic Distortion

d) Line Regulation

e) Load Regulation Adjustment

f) Amplitude Stability

g) Frequency Response

h) AC Noise Level

i) 0.7 Lagging Power Factor

j) 0.7 Leading Power Factor

This calibration procedure assumes that the power source will be operated from the 115 volt 47 to 65 Hz AC line. For higher values of AC line voltage, a 240 volt variac and a 240 volt wattmeter must be substituted for those called out in this procedure. Consult Section 2.2.1 of this instruction manual for operation from other than the 115 volt AC line.

This calibration procedure further assumes that the power source is tested on the 0 to 135 volt range. Performance is very similar on the other two ranges. The following table illustrates the change in measurement voltage and impedance level when evaluating the power source on various output voltage ranges.

TABLE 4-1			
Rated Output Voltage	30V AC	75V AC	135V AC
78% of Rated Output Voltage	23.4V AC	58.5V AC	105V AC
Resistive Load for 250 VA Output at Rated Output Voltage	3.6Ω	22.5Ω	72.9Ω
Resistive Load for 250 VA Output at 78% of Rated Output Voltage	2.19Ω	13.7Ω	44.1Ω

Section 2.4 of this instruction manual indicates the procedure required to change output voltage ranges and Section 2.8 indicates some potential problems associated with output wiring IR drop on the low voltage ranges. When checking load regulation and amplitude stability, care should be taken to use a four-wire connection such that the external load and the measurement equipment have completely separate wiring from the large binding posts at the rear of the power source.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the calibration procedure assuming that the input line voltage has a nominal value of 115 volts rms and that the power source is tested on the 0 to 135 volt AC range. Some equipment substitutions will be required if this is not the case.

a) Oscilloscope, Tektronix 533A with "W" plug-in.

b) 3.0 KVA Variac, General Radio W30M or equivalent.

c) 3.0 KVA Wattmeter, Simpson Electric or equivalent

d) Distortion Analyser, H.P. 330B or equivalent

e) Differential Voltmeter, Fluke 883A or equivalent

f) Multi-range 250 watt load box, or individual 250 watt power resistors, as defined in Table 4-1. Dale type NHL resistors or equivalent.

g) Expanded Scale (about 115 VAC) strip chart recorder, Voltron Model 89.038 or equivalent

h) Multimeter, Simpson 260 or equivalent

4.3 INITIAL ADJUSTMENTS

4.3.1 Connect the Model 251T Power Source as shown in Figure 4-1. Turn the GAIN control fully counterclockwise. Adjust the line voltage to its nominal value with the variac. Turn the POWER switch "on." The wattmeter should indicate 100 watts or less at nominal line voltage. If a problem is encountered, perform step 4.3.2 below.

4.3.2 Remove the bottom cover from the unit and connect the differential voltmeter between terminal 1 and terminal 2 of T3. Adjust potentiometer A3R7 so that the DC voltage across the primary of T3 is 0.00 volts ±5 millivolts. This balances and minimizes the collector current in both halves of the output stage.

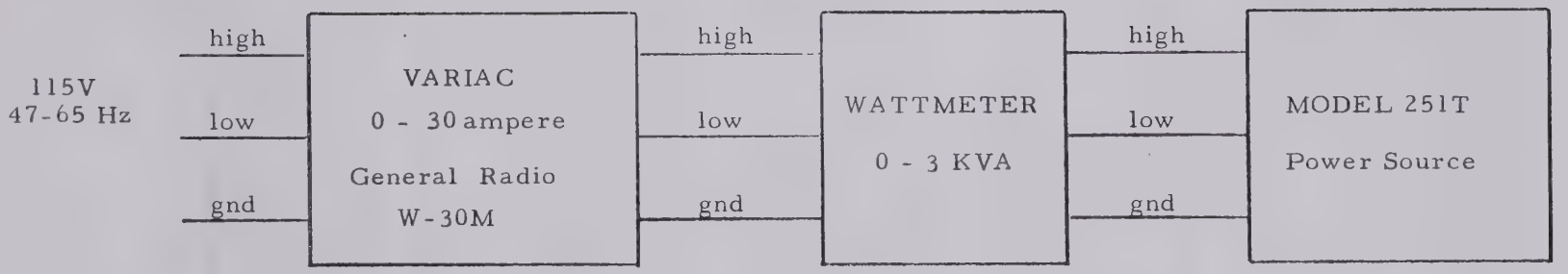
4.3.3 Connect the differential voltmeter to the power output terminals at the rear of the unit and select the 0 to 30 volt range. Adjust the GAIN control for a 30 volt output with the oscillator set to 400 Hz. Adjust the meter calibration control A6R1 so that the front panel meter and the differential voltmeter correlate within one per cent of each other. Vary the frequency from 45 Hz to 20 KHz and check that the front panel meter reads within ±3 per cent of the correct value.

4.3.4 Remove power from the unit and select the 0 to 75 volt range with the rear panel switch. Set the oscillator to 400 Hz and adjust the output to exactly 75 volts while reading the differential voltmeter. Select resistor A6R5 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45 Hz to 20 KHz and check that the front panel meter reads within ±3 per cent of the correct value.

4.3.5 Remove power from the unit and select the 0 to 135 volt range with the rear panel switch. Set the oscillator to 400 Hz and adjust the output to exactly 135 volts while reading the differential voltmeter. Select resistor A6R4 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45 Hz to 20 KHz and check that the front panel meter reads within ±3 per cent of the correct value.

4.4 AC LINE INPUT POWER and OVERLOAD ADJUSTMENT

4.4.1 Connect the Model 251T Power Source as shown in Figure 4-3. Select the 135 volt range with the rear panel switch and adjust the output voltage of the power source to 105 volts rms (78 per cent of rated output voltage) at 400 Hz. Close switch S2 (44.1 ohm load) and readjust the output voltage slightly, if required, in order to maintain a 105 volt output. The power source should deliver a clean sine wave output with less than 0.30 per cent distortion. Vary the frequency from 45 Hz to



See Table 2-1 for AC line input wiring to the Model 251T Power Source. Unit is normally wired for 105 to 125 volt AC line operation.

FIGURE 4-1. Test set up for initial adjustments of Model 251T Power Source.

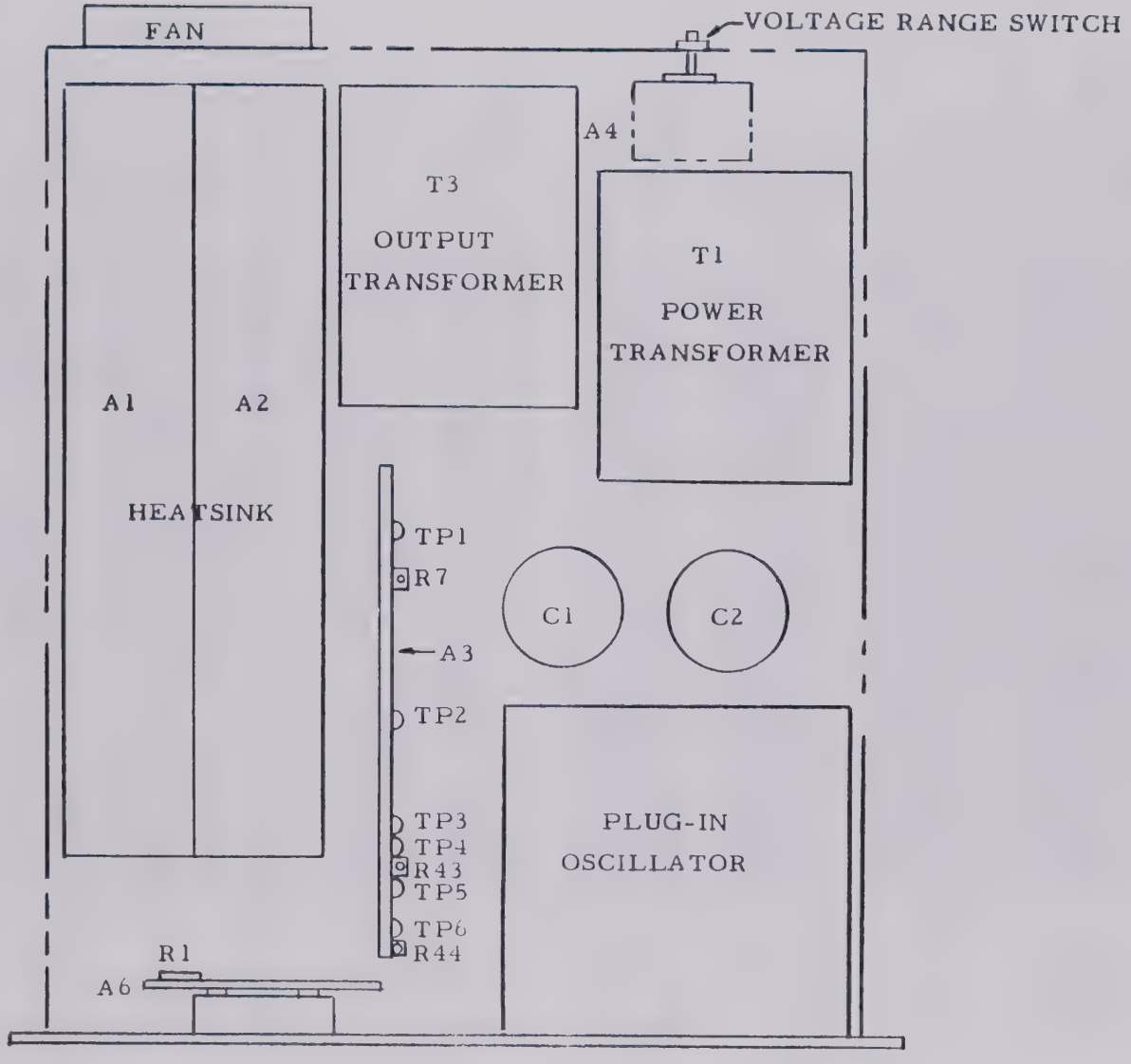


FIGURE 4-2. INTERNAL ADJUSTMENTS FOR MODEL 251T POWER SOURCE

20 KHz and check that the distortion does not exceed 0.5 per cent over the AC input line voltage range of 105 to 125 volts while maintaining the output voltage at 105 volts rms. Adjust potentiometer A3R43 so that no clipping or excessive distortion occurs on the positive peak of the output wave form under worst case conditions outlined above. Adjust potentiometer A3R44 so that no clipping or excessive distortion occurs on the negative peak of the output wave form under worst case conditions outlined above. These two adjustments may interact somewhat, so care should be taken not to move one adjustment excessively without checking the effect on the other adjustment.

4.4.2 With the AC input line voltage adjusted to its maximum value (normally 125 volts AC), close switch S2 and set the output voltage to 105 volts rms at 400 Hz. The AC line wattmeter should indicate less than 950 watts.

4.4.3 Repeat step 4.4.2 except close switch S1 instead of S2 and set the output voltage to 135 volts rms (100 per cent of rated output voltage). Maintain the input AC line voltage at 125 volts rms. The AC line wattmeter should indicate less than 800 watts.

4.4.4 Repeat step 4.4.2 except open switch S1 (no load on output of power source). The AC line wattmeter should indicate less than 150 watts with a line voltage of 125 volts rms.

4.4.5 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage levels should be taken from those given in Table 4-1.

4.5 VOLTAGE, POWER OUTPUT and HARMONIC DISTORTION

4.5.1 Connect the Model 251T Power Source as shown in Figure 4-3. Select the 135 volt range with the rear panel tap switch. Adjust the variac to provide a 115 VAC line input and allow the power source to warm up for a few minutes. Set the oscillator output to 400 Hz and adjust the output of the amplifier with the GAIN control to provide 135 volts rms (100% of rated output). Close switch S1 so that the 72.9 ohm load is across the output of the power source.

4.5.2 Vary the AC line voltage from 105 to 125 volts with the variac and check that no significant clipping is observed on the sine wave output with the oscilloscope. The harmonic distortion must be less than 0.3 per cent over the full line voltage range.

4.5.3 Set the oscillator output to 45 Hz and adjust the output of the power source to 135 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.5 per cent over the full line voltage range.

4.5.4 Set the oscillator output to 1 KHz and adjust the output of the power source to 135 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.30 per cent over the full line voltage range.

4.5.5 Set the oscillator output to 20 KHz and adjust the output of the power source to 135 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.5 per cent over the full line voltage range.

4.5.6 Repeat steps 4.5.1 through 4.5.4 except set the output of the power source to 105 volts rms (78% of rated output) and close switch S2 instead of S1. The harmonic distortion must be less than 0.30 per cent from 200 Hz to 1 KHz, and less than 0.5 per cent from 45 Hz to 20 KHz.

4.5.7 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage levels should be taken from those given in Table 4-1.

4.6 LINE REGULATION

4.6.1 Connect the Model 251T Power Source as shown in Figure 4-3. Select the 135 volt range with the rear panel tap switch. Set the oscillator frequency to 400 Hz. Close switch S1 (72.9 ohm load) and adjust the output of the power amplifier to 135 volts rms (100 per cent of rated output voltage) at 400 Hz.

4.6.2 Vary the line voltage from 105 volts to 125 volts AC and measure the change in output voltage of the power amplifier. This change should be less than 0.68 volts rms.

4.6.3 Set the frequency of the oscillator to 5 KHz and repeat 4.6.1 and 4.6.2. The change in the output voltage should be less than 0.68 volts rms.

4.6.4 Set the frequency of the oscillator to 20 KHz. Repeat step 4.6.1 and 4.6.2. The change in output voltage should be less than 0.68 volts rms.

NOTE

Care should be taken to insure that the output amplitude of the oscillator remains stable and independent of line conditions during this test.

4.6.5 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage level should be taken from those given in Table 4-1.

4.7 LOAD REGULATION ADJUSTMENT

The load regulation adjustment is accessible from the front panel of the power source and is usually adjusted for zero regulation at 400 Hz. This adjustment is somewhat sensitive to the output voltage range and should be readjusted whenever the output voltage range is changed.

4.7.1 Connect the Model 251T Power Source as shown in Figure 4-3. Check that the load is connected to the large red and white binding posts at the rear of the power source. The output voltage may be monitored either at the rear or the front of the power source. If it is monitored at the rear of the power source, care should be taken to use four-wire sensing. Adjust the output voltage of the Model 251T Power Source to 105 V rms output (or 78 per cent of rated output voltage) at 400 Hz.

4.7.2 Place the differential voltmeter on the 1000 volt AC range and connect it across the front panel output terminals of the power source. Adjust R5 (accessible from the front panel of the power source and labeled REG) so that the output voltage variation is less than 20 millivolts as the 44.1 ohm load is added and removed. Maintain the line voltage at 115 volts during this test.

4.7.3 Set the frequency of the oscillator to 5 KHz. Adjust the output amplitude of the power source to 105 volts rms with no load on the output of the power source. The output of the power source should change less than ±1.05 volts when loaded with the 44.1 ohm resistor. Maintain the line voltage at 115 volts during this test.

4.7.4 Set the frequency of the oscillator to 45 Hz and repeat 4.7.3. The output of the power source should change less than ±1.05 volts.

4.7.5 Set the frequency of the oscillator to 20 KHz and repeat 4.7.3. The output of the power source should change less than ±2.10 volts. Capacitor C3, in the secondary circuit of T2, has been set at the factory for optimum load regulation at 20 KHz and may be changed if required.

4.7.6 This procedure (steps 4.7.1 through 4.7.5) may be performed for any of the other output voltage ranges, rather than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage levels should be taken

from those given in Table 4-1. Care should be taken to use non-inductive load resistors, especially on the 30 volt and 75 volt output voltage ranges where load impedances are very low and a few microhenries of inductance will significantly influence the power factor at 5 KHz to 20 KHz. The load regulation must remain within a ±1 per cent band from 45 Hz to 5 KHz and must remain within a ±2 per cent band from 45 Hz to 20 KHz.

4.8 AMPLITUDE STABILITY

4.8.1 Connect the Model 251T Power Source as shown in Figure 4-3. Adjust the AC input line voltage to 115 volts rms. Adjust the output of the power source to provide 115 volts rms output (85.3 per cent of rated output voltage) at 400 Hz. Connect a 52.8 ohm (250 VA) load to the output terminals at the rear of the power source and check that the REG control has been set to provide a zero output impedance.

4.8.2 Connect an AC expanded scale (about 115 volts rms) strip chart recorder across the output terminals of the power source and record the drift during a 24 hour period. This drift should be less than ± 0.29 volts rms. Disregard the drift during the first hour, as this represents initial warm-up drift. Care should be taken to insure that the ambient temperature is held constant within ± 3 degrees C for this test.

4.8.3 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage level should be taken from those given in Table 4-1 consistent with the dynamic range of the specific expanded scale strip chart recorder employed for the test.

4.9 FREQUENCY RESPONSE

4.9.1 Connect the Model 251T Power Source as shown in Figure 4-3. Adjust the input AC line voltage to 115 volts rms. Adjust the output of the power source to provide 135 volts output (100 per cent of rated output voltage) at 400 Hz.

4.9.2 Vary the output frequency of the oscillator from 45 Hz to 20 KHz and monitor the output voltage of the power source with a differential voltmeter under no-load conditions. The output of the power source should vary less than ±8.0 volts rms from 45 Hz to 20 KHz.

4.9.3 Close switch S1 and repeat 4.9.1 and 4.9.2. The output of the power source should vary less than ±8.0 volts rms from 45 Hz to 20 KHz.

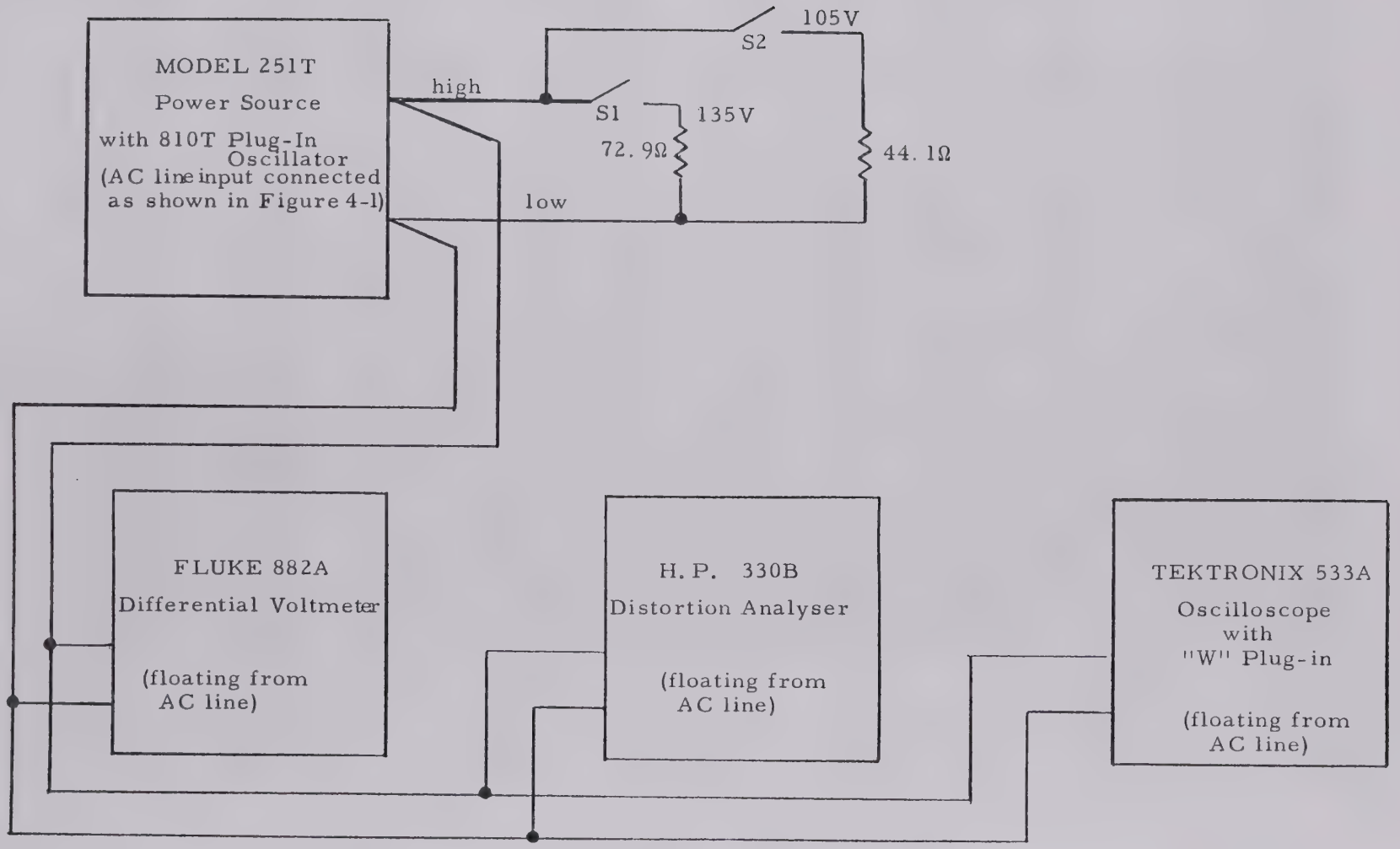


FIGURE 4-3. Test circuit for Model 251T Power Source

4.9.4 This procedure may be performed for any of the other output voltage ranges, other than the 0 to 135 volt range, if desired. In this case, the load impedance and output voltage level should be taken from those given in Table 4-1. The output must vary less than ±0.5 dB from 45 Hz to 20 KHz.

4.10 AC NOISE LEVEL

4.10.1 Connect the Model 251T Power Source as shown in Figure 4-3. Adjust the line voltage to 115 volts rms. Adjust the output of the power source to provide 105 volts rms (78% of rated output voltage) at 400 Hz.

4.10.2 Close switch S2 and monitor the output of the power source with the Tektronix 533A Oscilloscope with a "W" plug-in. Using the offset feature of the "W" plug-in, observe the positive peak of the output voltage at a vertical sensitivity of .2 volt per centimeter and a sweep rate of 5 milliseconds per centimeter. The peak-to-peak noise and ripple should not exceed 0.093 volts (70 dB below full output). The noise and ripple output may be slightly greater if the unit is tested at an output frequency of less than 200 Hz.

4.10.3 Remove the plug-in oscillator and short pins 1 and 2 together of the terminal strip TB1 located on the rear panel of the Model 251T. The AC rms noise in the output should now be less than 10.5 millivolts rms (80 dB below full output) when read on the differential voltmeter. Remove the short from pins 1 and 2 of TB1 and then insert the plug-in oscillator into the 251T.

4.10.4 Steps 4.10.1 through 4.10.3 may be performed on any of the other output voltage ranges, if desired. The switch at the rear of the unit should be selected to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1. The following chart gives the acceptable noise level output on each voltage range.

Rated Output Voltage	30V AC	75V AC	135V AC
Peak-to-Peak Noise Level with 250 VA Load (See 4.10.2)	.021V p-p	0.052V p-p	0.093V p-p
Rms Noise Level at No Load (See 4.10.3)	2.34mv rms	5.85mv rms	10.5mv rms

4.11 0.7 LAGGING POWER FACTOR

4.11.1 Connect the Model 251T Power Source as shown in Figure 4-3. Select the load circuit to correspond with the required output voltage range. Figure 4-4 illustrates the load circuit and gives load parameter values for 250 VA 0.7 power factor at 400 Hz with 78 per cent of rated output voltage from the power source. This represents the worst case inductive load for maximum power dissipation inside the power source.

4.11.2 Set the oscillator frequency to 400 Hz and adjust the GAIN control for 78 per cent of rated output voltage. Check that the power source produces a stable output with no high-frequency oscillation or excessive distortion. Refer to Section 4.5 of this instruction manual for the procedure to measure harmonic distortion. This distortion must be less than 0.3 per cent at 400 Hz. The overload adjustments A3R43 and A3R44 may have to be rotated counterclockwise slightly with a 0.7 power factor load to meet the 0.3 per cent distortion specification.

4.11.3 The REG control usually does not require significant readjustment in order to provide a zero regulation with a 0.7 power factor load at 400 Hz. If the unit is to be operated at a 0.7 power factor in the high frequency region, i.e., 5 KHz to 20 KHz, then it may be necessary to readjust the REG control. In this case, rotate the front panel REG control until zero regulation is obtained at the specific frequency and load condition.

4.11.4 The AC line input power is 950 watts maximum with an 0.7 power factor load at 78 per cent of rated output voltage and an input line voltage of 125 volts rms.

4.11.5 The above tests may be repeated at frequencies other than 400 Hz provided that the inductance of the series inductor is changed inversely proportional to the absolute value of the test frequency. For example, at 1 KHz the inductance value must be divided by 2.5. The series resistance value remains unchanged.

4.12 0.7 LEADING POWER FACTOR

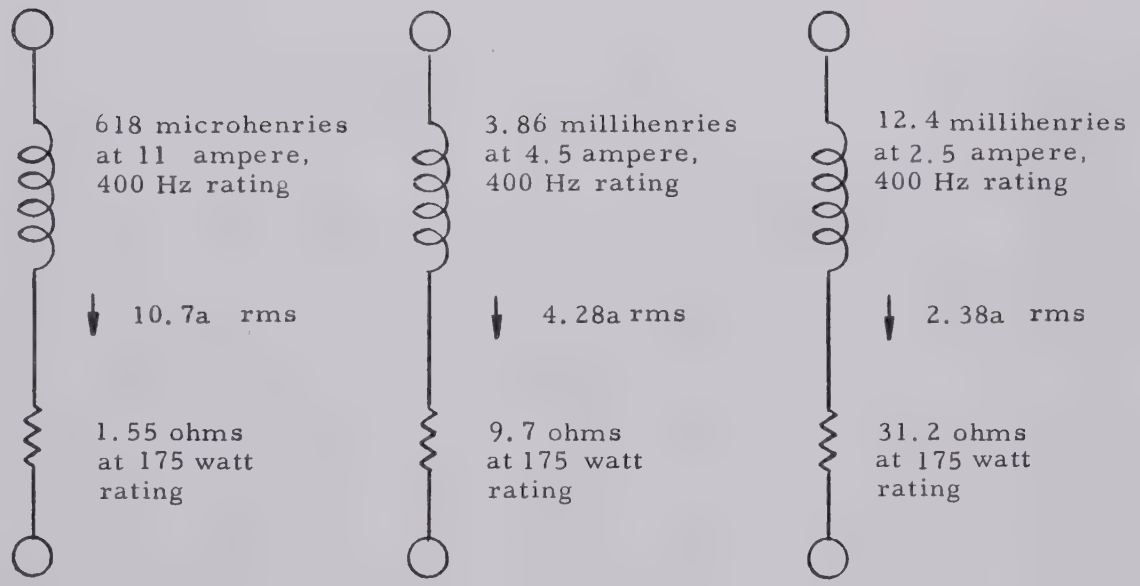
4.12.1 Connect the Model 251T Power Source as shown in Figure 4-3. Select the load circuit to correspond with the required output voltage range. Figure 4-5 illustrates the load circuit and gives load parameter values for 250 VA 0.7 power factor operation at 400 Hz with 78 per cent of rated output voltage from the power source. This represents the worst case capacitive load for maximum power dissipation inside the power source.

4.12.2 Set the oscillator frequency to 400 Hz and adjust the GAIN control for 78 per cent of the rated output voltage. Check that the power source produces a stable output with no high frequency oscillation or excessive distortion. Refer to Section 4.5 for the procedure to measure harmonic distortion. This distortion must be less than 0.3 per cent at 400 Hz. The overload adjustments A3R43 and A3R44 may have to be rotated counterclockwise slightly with a 0.7 power factor load to meet the 0.3 per cent distortion specification.

4.12.3 The REG control usually does not require significant readjustment in order to provide a zero regulation with a 0.7 power factor load at 400 Hz. If the unit is to be operated at a 0.7 power factor in the high frequency region, i.e., 5 KHz to 20 KHz, then it may be necessary to readjust the REG control. In this case, rotate the front panel REG control until zero regulation is obtained at the specific frequency and load condition.

4.12.4 The AC line input power is 950 watts maximum with an 0.7 power factor load at rated output voltage and an input line voltage of 125 volts rms.

4.12.5 The above tests may be repeated at frequencies other than 400 Hz provided that the capacitance of the series capacitor is changed inversely proportional to the absolute value of the test frequency. For example, at 1 KHz the capacitance value must be divided by 2.5. The series resistance value remains unchanged.



0-30 VAC Range
250 VA .7 pf load
at 23.4 V rms
across entire load

0-75 VAC Range
250 VA .7 pf load
at 58.5 V rms
across entire load

0-135 VAC Range
250 VA .7 pf load
at 105 V rms
across entire load

FIGURE 4-4. Circuit for 250 VA, 0.7 Lagging Power Factor Load at 400 Hz.

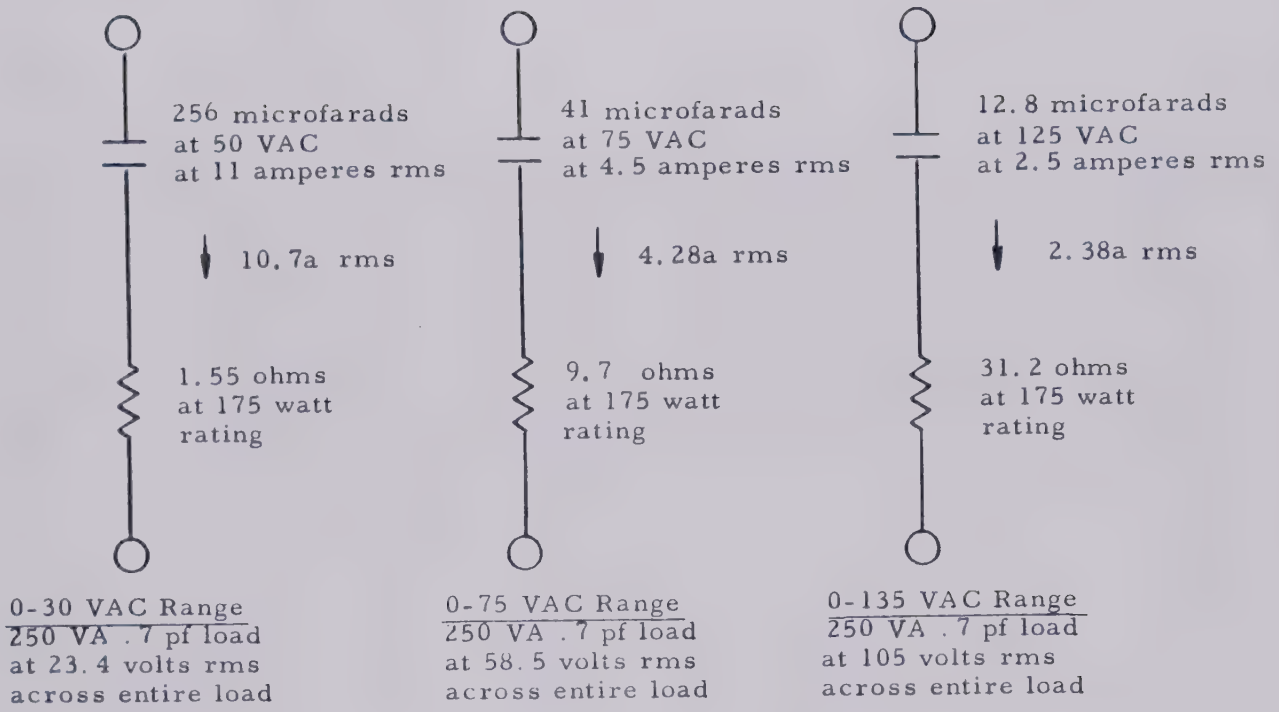


FIGURE 4-5. Circuit for 250 VA, 0.7 Leading Power Factor Load at 400 Hz.

MAINTENANCE AND TROUBLE SHOOTING

5.1 GENERAL

The Model 251T Power Source is a solid state unit and will require a minimum of maintenance. Careful and regular performance of periodic preventive maintenance will reduce the probability of failure.

5.2 CLEANING

Remove dust, dirt and other foreign material using a small brush and vacuum cleaner. Low pressure air may be used if a vacuum cleaner is not available. When using the air, insure that the air flow is directed so that the foreign material will be blown away from the unit being cleaned. Use a dust-free, lint-free cloth and a suitable solvent such as Methyl-Ethyl-Ketone to remove contamination not readily removable by vacuum or forced air methods. When cleaning printed circuit boards, do not scratch the printed circuit wiring. If solvent is used, allow all affected areas to thoroughly air dry prior to placing in use.

5.3 PERIODIC PREVENTIVE MAINTENANCE

The periodic maintenance outlined in Table 5-1 should be performed to insure for maximum, failure-free operation of the 251T Power Source. Follow safety outlines of this manual when performing any maintenance on this unit. No lubrication is required for the 251T Power Source.

TABLE 5-1

PREVENTIVE MAINTENANCE		
Interval	Area of Maintenance	Procedure
Weekly	Exterior of unit, especially front and rear panel.	Inspect controls, indicators, connectors, wiring, and hardware for contamination by dust or dirt, security of mounting or connection, and signs of damage. Inspect fan for free rotation. Follow safety guidelines outlined in this manual.
Monthly	Interior of unit, including individual assemblies.	With power off remove top and bottom covers of unit. Inspect electrical parts and wiring (including printed circuit wiring) for dust, dirt, corrosion, and evidence of overheating and other damage.

(cont.) TABLE 5-1

PREVENTIVE MAINTENANCE		
Interval	Area of Maintenance	Procedure
Bi-yearly	Heatsink Assemblies (A1 and A2)	With power off remove heatsink assemblies from unit and separate. Clean the heatsinks of all dust and dirt using a forced air bath, inspect printed circuit boards for dust, dirt, security of mounting and evidence of over heating. Reassemble and reinstall heatsinks in unit. Failure to perform this maintenance will result in reduced thermal transfer efficiency and may lead to failure of the power source.

5.4 TROUBLESHOOTING

WARNING

Voltages up to 250 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

5.4.1 The equipment required for maintenance of this power source is the same as that called out in section 4.2 of this manual. In addition, a null voltmeter, as the Hewlett Packard Model 419A is required for some tests associated with the pre-amplifier assembly A3.

5.4.2 Troubleshooting techniques normally used for high power solid state amplifiers are applicable for this equipment. A schematic diagram for the main chassis assembly, the positive heatsink assembly A1, and the negative heatsink assembly A2 is given in drawing E4025-070. A schematic diagram for the pre-amplifier assembly A3 is given in drawing D4025-071. Refer to

section 4.0 of this manual for the procedures required to varify power source performance.

5.4.3 If a problem appears in the power source, it must be isolated to a specific section of the unit. Before servicing the amplifier, check that the AC power input to the unit is of the proper amplitude and frequency. Check that the signal input to the power amplifier is also of the proper amplitude (approximately 5 volts rms) and frequency (45 Hz to 20 KHz). Check that the output load on the power amplifier is not excessive or that the load starting transients are not excessive. Check that the output of the oscillator is coupled to the input of the power amplifier through the 12 pin connector on the rear of the power amplifier.

5.4.4 Table 5-2 gives disassembly and assembly instructions for the heatsinks, A1 and A2. Table 5-3 gives disassembly and assembly instructions for the replacement of power transistors located on the heatsink assemblies, A1 and A2. Table 5-4 gives disassembly and assembly instructions for the replacement of power resistors located on the heatsink assemblies, A1 and A2. Table 5-5 gives instructions for the replacement of the filter capacitors, C1 and C2. Table 5-6 gives instructions for the replacement of the power transformer, T1. Table 5-7 gives instructions for the replacement of the output transformer, T3.

5.4.5 The troubleshooting tree shown in Figure 5-1 should be used to determine the defective component and/or components.

TABLE 5-2

Disassembly and Assembly of Heatsinks, A1 and A2 All directions are given as viewed from the front of the power source with top-side up.	
Disassembly and assembly of heatsinks, A1 and A2.	1. Remove the eight #6 retaining screws and remove top cover. 2. Remove the two flat head #8 retaining screws located on the left side rail and carefully rotate heatsink assembly up and out of the unit. 3. A service loop in the wire bundle is provided for removal without disconnecting wiring. NOTE: The actual heatsink must be electrically isolated, while operating the power source. 4. Remove the heatsink cover from the A2 assembly by removing the two #8 retaining screws and washers.

(cont.) TABLE 5-2

Disassembly and Assembly of Heatsinks, A1 and A2 All directions are given as viewed from the front of the power source with top-side up.	
Disassembly and assembly of heatsinks, A1 and A2.	5. Remove the two #4 retaining bolts from each flange of the heatsinks. Remove the plexiglass insulators... that isolate each heatsink from each other. Note the position of shoulder washers to isolate the heatsinks from each other. These must be replaced when the unit is reassembled. Lay each heatsink assembly so that the flanges are up and the insulated heatsink fins are down. Do not remove the insulators (black vinyl) from the heatsink fins. The two assemblies should now be positioned so that the P. C. Boards and components are readily accessible for test and repair.
Reassembly of A1 and A2 heatsink assemblies.	1. Place heatsinks so that they are flange to flange, with wire exiting at the same end. Between flanges, place the plexiglass dividers. Then bolt together, with the following progression from screw head to nut : screw head, flat washer, shoulder washer (with sleeve into flange), flange #(1), plexiglass divider, flange #(2), shoulder washer (with sleeve into flange), flat washer, lock washer, and then nut. (Four places). 2. Make sure that the heatsink fin insulators are all in place and wire cable clamps are secure. 3. Install heatsink cover on A2 heatsink (right hand side) by using two screws into the six-sided standoffs on the heatsink. The notched end of the cover goes toward the rear. 4. Place assembly back into unit with the heatsink cover to the inside and notched end to the rear. Fasten to left hand side rail with two flat #8 screws. 5. At this point, to check correct reassembly continuity check from each heatsink to each other and from each heatsink to side rail. Scratch through anodize surface to insure good electrical contact. The heatsinks must be electrically isolated from each other and from all other metal work. 6. Reinstall cover if desired.

TABLE 5-3

Replacement of Power Transistors in Heatsink	
Replacement of power transistors in heatsink.	1. Place heatsink assembly to be repaired on its side so that both the P. C. Board and the power transistors are accessible. 2. To replace a power transistor, unsolder the transistor from the P. C. Board at pads "B" and "E". (Remove all solder from the joint). 3. From the transistor side, remove the two #4 retaining screws and lockwashers and lift off the transistor. 4. Prep the heatsink area with a very small amount of thermate silicone compound and reinstall the transistor so that the base lead goes through the "B" hole in the P. C. Board and the emitter lead goes through the "E" hole in the P. C. Board, Reinstall the two #4 retaining screws and lockwashers. 5. Cut the transistor leads to approximately 1/16 above P. C. Board and solder the leads to the P. C. Board. This completes the transistor replacement. Replace any required resistors according to the procedure given in Table 5-4. Reassemble and install the heatsinks according to the procedure given in Table 5-2.

TABLE 5-4

Replacement of Power Resistors in Heatsink	
Replacement of power resistors in heatsink.	1. To replace power resistors from the P. C. Boards, place heatsink on bench with P. C. Boards up. Unsolder resistor and discard. 2. Prepare replacement resistor according to heatsink assembly drawing 4025-401 by bending leads to configuration shown. 3. Solder resistor to board in location specified on assembly drawing 4025-401. This completes the resistor replacement. 4. Reassemble and install the heatsinks according to the procedure given in Table 5-2.

TABLE 5-5

Replacement of Filter Capacitors, C1 and C2	
Replacement of filter capacitors, C1 and C2.	1. Remove the eight #6 retaining screws and remove the top cover. 2. Remove the eight #6 retaining screws and remove the bottom cover. 3. Place the unit on its right-hand side rail. 4. Label wires to be removed with termination data (ex: "C1-(+)" or "C2-(-)"). Remove retaining nuts and lockwashers from capacitor studs and remove wires. 5. From the top side, loosen the capacitor clamp until the capacitor can be withdrawn. Then remove the capacitor by lifting up and out. 6. Install the new capacitor by placing in the clamp until it bottoms out against the false bottom, with the capacitor studs protruding through the clearance hole cut in the false bottom. Insure that the capacitor studs are properly orientated, with the "+" stud adjacent to the "+" wiring and the "-" stud adjacent to the "-" wiring. Tighten the capacitor clamp until secure. 7. Reinstall the wiring and secure with the capacitor hardware. 8. Reinstall top and bottom covers.

TABLE 5-6

Replacement of Power Transformer, T1 All directions are given as viewed from the front of the power source with top side up.	
Replacement of power transformer, T1.	1. Remove eight #6 retaining screws from top cover and remove top cover. 2. Remove eight retaining screws from bottom cover and remove bottom cover. 3. Place unit top side up, label wires to transformer by transformer terminal number. Unsolder wires from terminal lugs No. 1 through 8 and fold bundles out of the way. Unbolt wires from terminals 9, 10 and 11. Keep fastening hardware with the wire lugs. Gently fold wire bundle back away from the transformer. 4. Unbolt the transformer support foot from the false bottom of the unit. This screw is located at the left-front of the transformer. CAUTION - This transformer is heavy and requires support until removed. 5. Unbolt the four transformer retaining bolts located on the right-hand side rail of the unit. The transformer will now be free and ready to remove from the unit. Support the transformer until ready to remove. 6. Slide the transformer slightly to the center of the unit and lift up to remove from the top. 7. To reinstall the transformer, reverse the order of the procedure for removing.

TABLE 5-7

Replacement of Output Transformer, T3	
Replacement of output transformer, T3.	1. Remove the eight #6 retaining screws from the top cover and remove top. 2. Remove the eight retaining screws from the bottom cover, and remove bottom. 3. Place the unit on its right-hand side rail. 4. Label wires to be removed with the number of the transformer terminal it is attached to. Unsolder wires from transformer terminals 3, 5, 7, 9, 11 and 13. Fold wires gently back out of the way. 5. Unsolder wires from transformer terminals 4, 6, 8, 10, 13 and 14. Fold back out of the way. 6. Unsolder single black wire from transformer terminal 2 on lower left-hand front of transformer. This is the wire to power resistor, R6. Fold wire gently back. 7. Unsolder wires from transformer terminal(s) 2 (4 wires). Fold out of the way. 8. Unsolder wires from transformer terminal(s) 1 (3 wires) fold out of the way. 9. While supporting transformer, unbolt transformer retaining bolts (4) from rear panel. Slide transformer slightly towards the front of the unit and remove from the top. 10. To install, reverse this procedure.

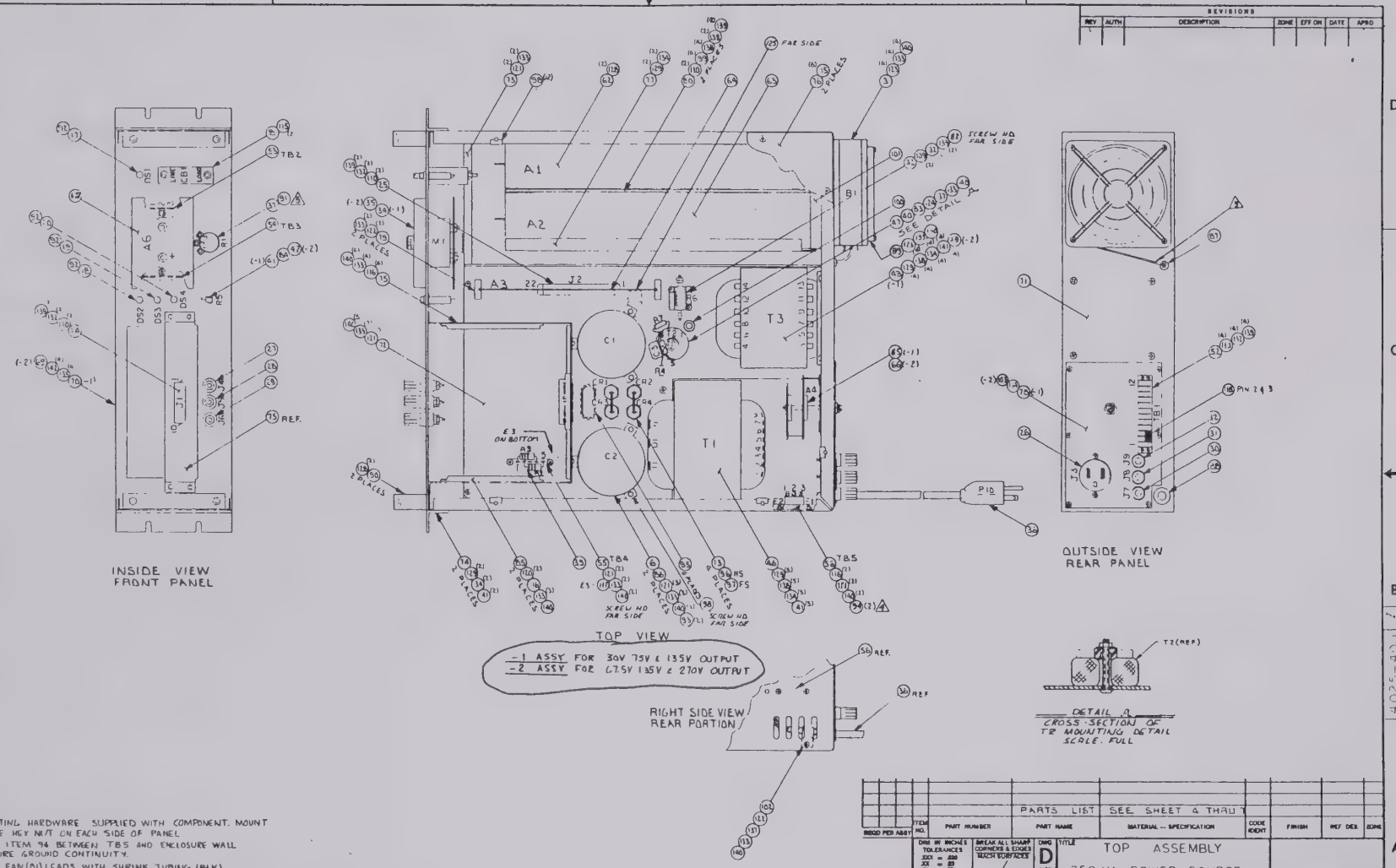
6.1 GENERAL

This section contains schematics and mechanical diagrams necessary for operation and maintenance of the Model 251T AC Power Source. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

6.2 REFERENCE DESIGNATIONS

Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Component Designation
A1	C30	A1C30
None	T1	T1
A3	CR1	A3CR1


INSIDE VIEW
FRONT PANEL
TOP VIEW
OUTSIDE VIEW
REAR PANEL
RIGHT SIDE VIEW
REAR PORTION
DETAIL A
CROSS-SECTION OF
T2 MOUNTING DETAIL
SCALE: FULL
-1 ASSY FOR 30V 75V & 135V OUTPUT
-2 ASSY FOR 67.5V 135V & 270V OUTPUT
FAR SIDE
SCREW HD
FAR SIDE
SEE DETAIL A
A1
A2
A3
A4
A6
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
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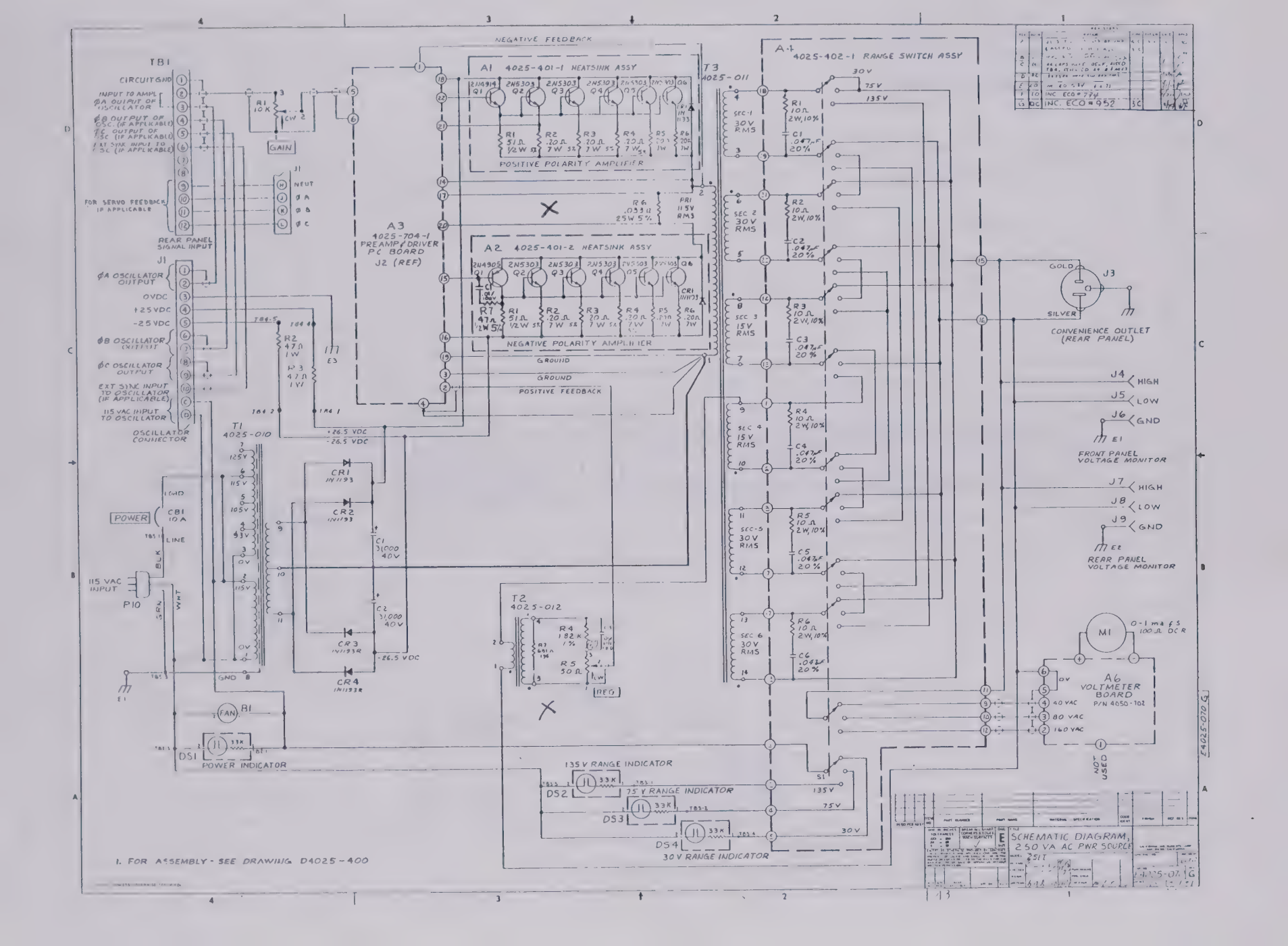
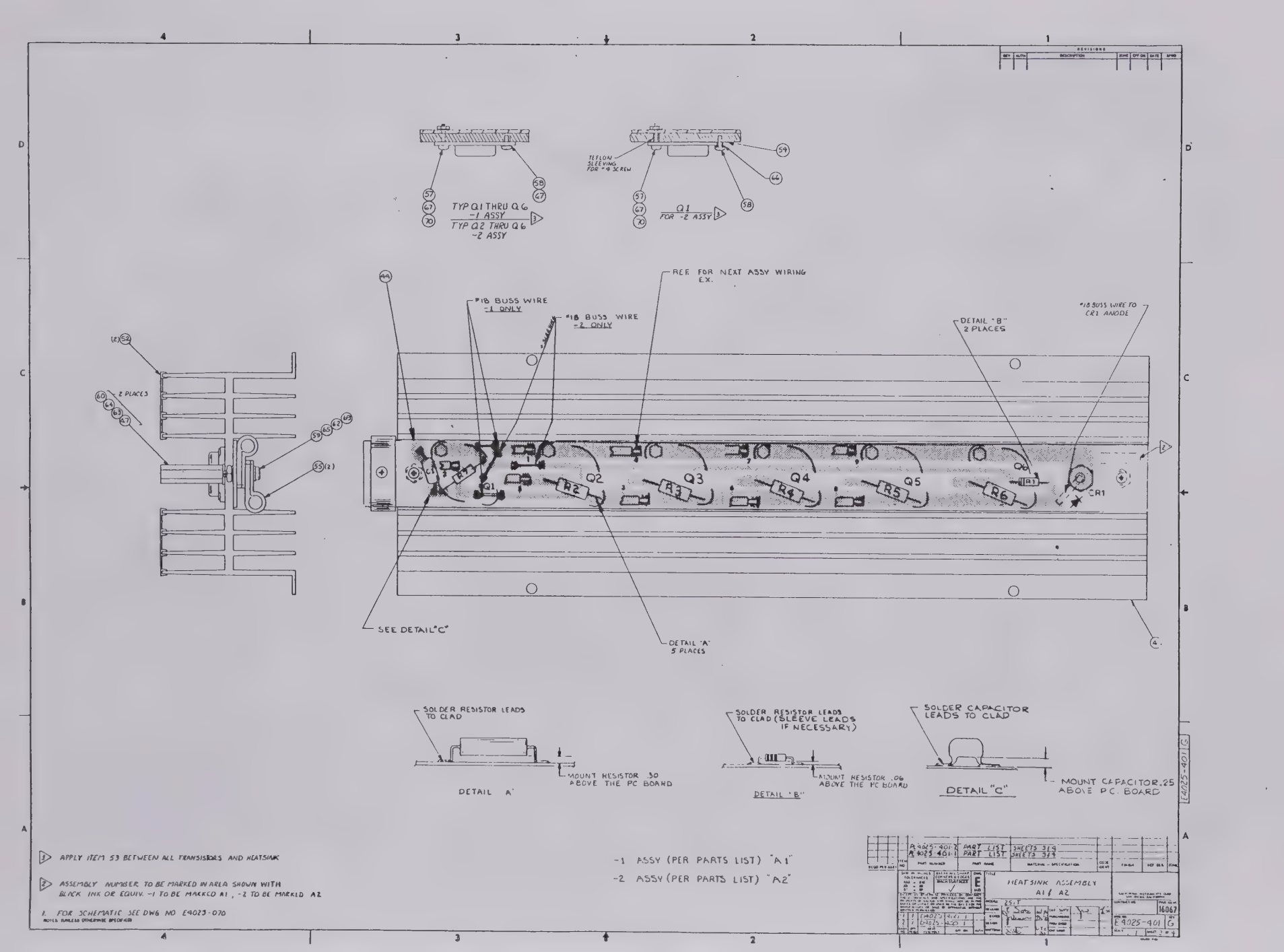
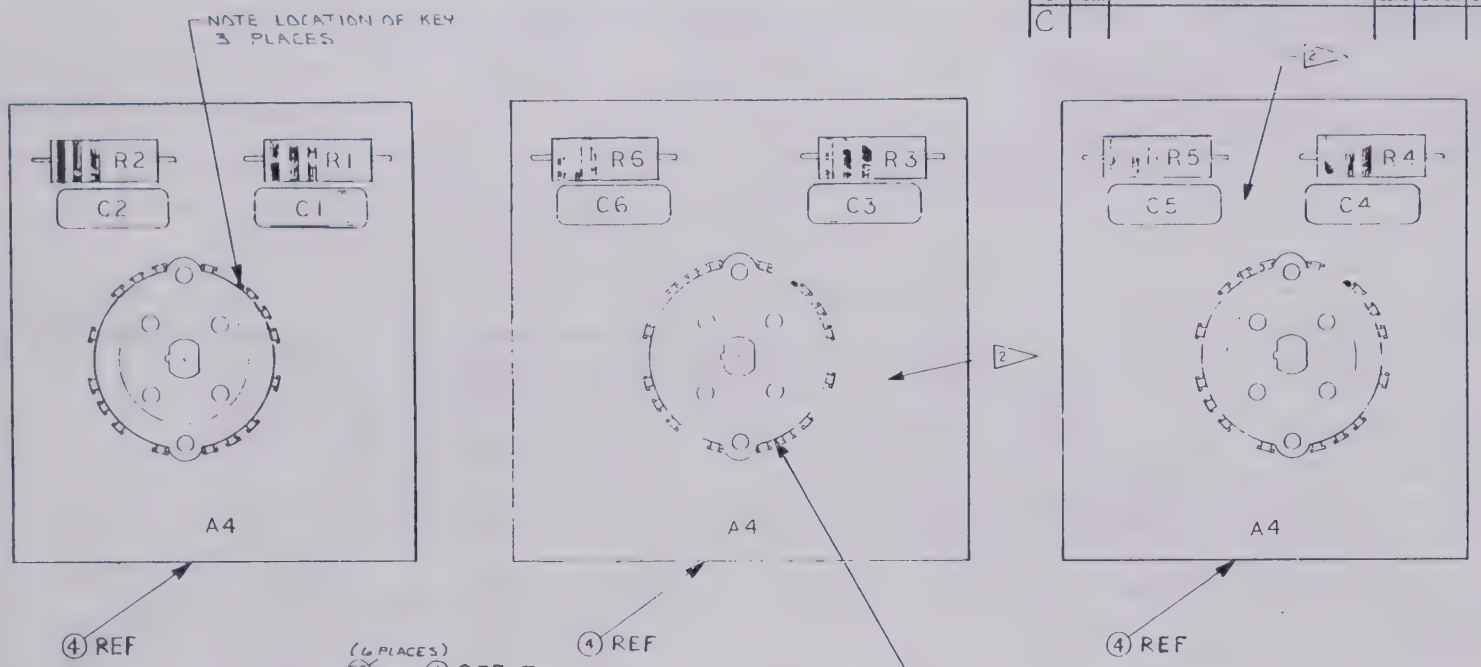
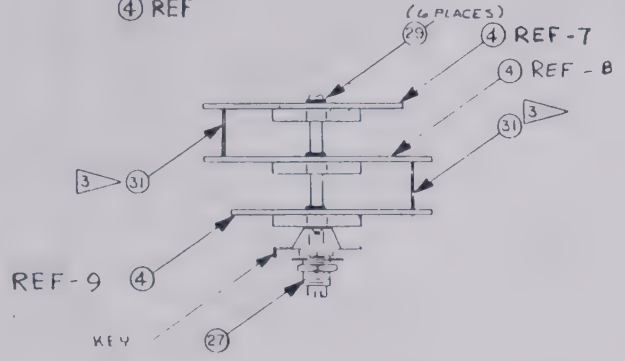
T40


A1 4025-401-1 HEATSINK ASSY
POSITIVE POLARITY AMPLIFIER
A2 4025-401-2 HEATSINK ASSY
NEGATIVE POLARITY AMPLIFIER
A3 4025-704-1 PREAMP & DRIVER PC BOARD J2 (REF)
A4 4025-402-1 RANGE SWITCH ASSY
NEGATIVE FEEDBACK
POSITIVE FEEDBACK
GROUND
GAIN
REAR PANEL SIGNAL INPUT
CONVENIENCE OUTLET (REAR PANEL)
FRONT PANEL VOLTAGE MONITOR
REAR PANEL VOLTAGE MONITOR
OSCILLATOR CONNECTOR
115 VAC INPUT
POWER INDICATOR
135 V RANGE INDICATOR
75 V RANGE INDICATOR
30 V RANGE INDICATOR
A6 VOLTMETER BOARD P/N 4050-102
NOT USED
1. FOR ASSEMBLY - SEE DRAWING D4025-400
SCHEMATIC DIAGRAM, 250 VA AC PWR SOURCE
4025-010 G


TYP Q1 THRU Q6 -1 ASSY
TYP Q2 THRU Q6 -2 ASSY
TEFLON SLEEVING FOR #4 SCREW
Q1 FOR -2 ASSY
#18 BUSS WIRE -1 ONLY
#18 BUSS WIRE -2 ONLY
REF FOR NEXT ASSY WIRING EX.
DETAIL "B" 2 PLACES
#18 BUSS WIRE TO CR1 ANODE
2 PLACES
SEE DETAIL "C"
DETAIL "A" 5 PLACES
Q1
Q2
Q3
Q4
Q5
Q6
R1
R2
R3
R4
R5
R6
CR1
SOLDER RESISTOR LEADS TO CLAD
MOUNT RESISTOR .30 ABOVE THE PC BOARD
DETAIL "A"
SOLDER RESISTOR LEADS TO CLAD (SLEEVE LEADS IF NECESSARY)
MOUNT RESISTOR .06 ABOVE THE PC BOARD
DETAIL "B"
SOLDER CAPACITOR LEADS TO CLAD
MOUNT CAPACITOR .25 ABOVE P.C. BOARD
DETAIL "C"
E4025-401 G
APPLY ITEM 53 BETWEEN ALL TRANSISTORS AND HEATSINK
ASSEMBLY NUMBER TO BE MARKED IN AREA SHOWN WITH BLACK INK OR EQUIV. -1 TO BE MARKED A1, -2 TO BE MARKED A2
1. FOR SCHEMATIC SEE DWG NO E4025-070
UNLESS OTHERWISE SPECIFIED
-1 ASSY (PER PARTS LIST) "A1"
-2 ASSY (PER PARTS LIST) "A2"
E4025-401-2 PART LIST SHEETS 3 & 4
E4025-401-1 PART LIST SHEETS 3 & 4
HEATSINK ASSEMBLY A1 & A2
16067
E4025-401 G

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
C						





3 WIRE USING ITEM 31 POINT TO POINT ALL LETTERS. EX. A TO A, B TO B, ETC.

2 SOLDER EYELET TO PAD, BOTH SIDES.

1. FOR SCHEMATIC SEE DWG. NO 4025-010

NOTES: (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
		SEE PARTS LIST (SHEET 3)						

DIM IN INCHES
TOLERANCES
XXX = .010
XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

TITLE: RANGE SWITCH ASSEMBLY

MODEL 251 T

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RELEASE		PURCHASING
CHECKER		PROJ ENGR
DESIGN	CWEED 8-12	SCHF ENGR
DRFTSMN	CWEED 8-12	

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
1	1	4025-400		

CALICO
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

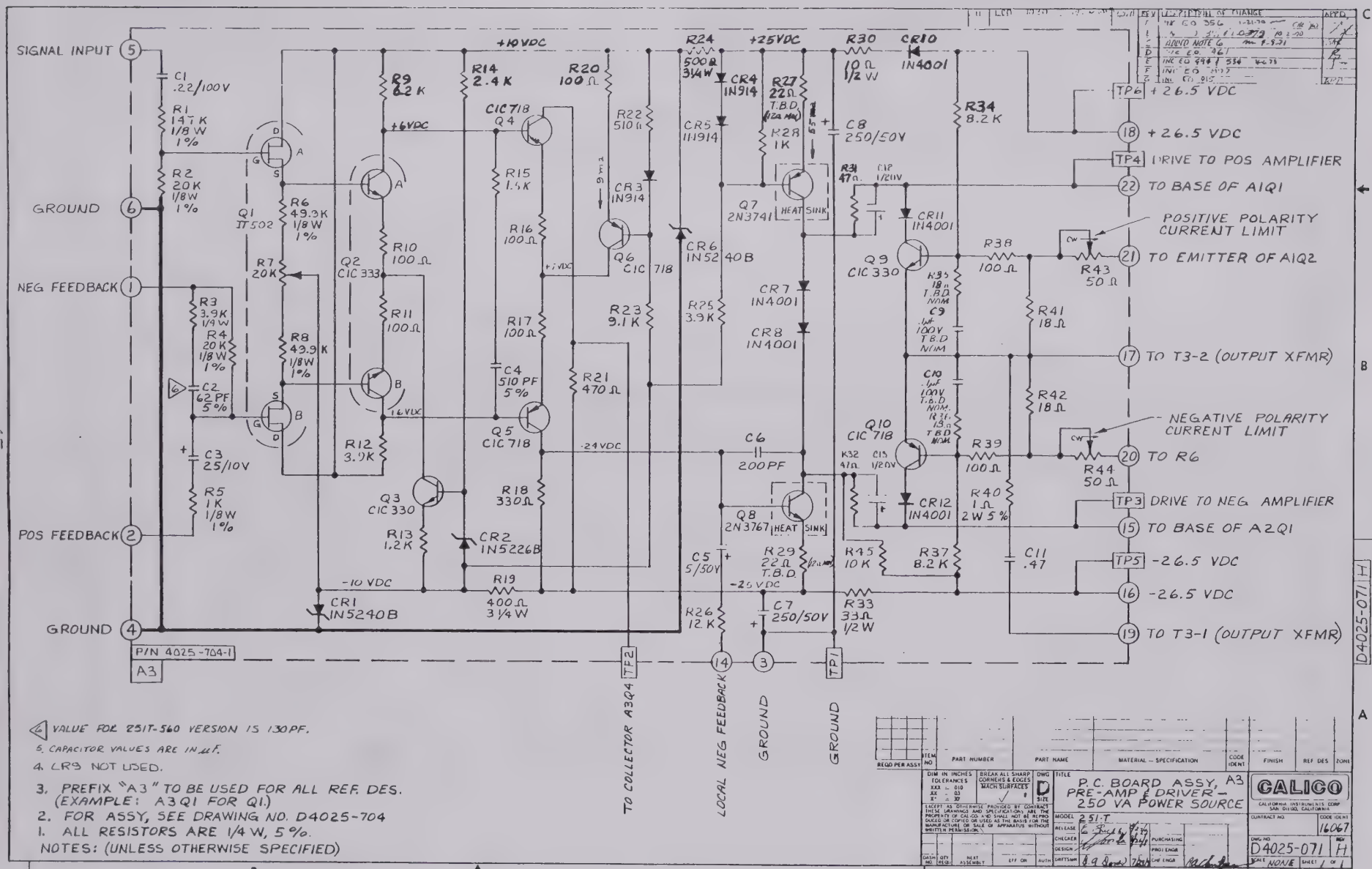
CONTRACT NO | CODE IDENT 16067

DWG NO 4025-402 | REV C

SCALE 2:1 | SHEET 2 OF 3

4025-402 C

CALICO P 300



△4 VALUE FOR 251T-560 VERSION IS 130PF.

5. CAPACITOR VALUES ARE IN μF.

4. CR9 NOT USED.

3. PREFIX "A3" TO BE USED FOR ALL REF. DES. (EXAMPLE: A3Q1 FOR Q1.)

2. FOR ASSY, SEE DRAWING NO. D4025-704

1. ALL RESISTORS ARE 1/4 W, 5%.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X ± .1 — BREAK ALL SHARP CORNERS & EDGES — MACH SURFACES √

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DWG SIZE D

TITLE: P.C. BOARD ASSY, A3 PRE-AMP & DRIVER — 250 VA POWER SOURCE

MODEL 251-T

RELEASE

CHECKER

DESIGN

DRFTSMN

PURCHASING

PROJ ENGR

CALICO — CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

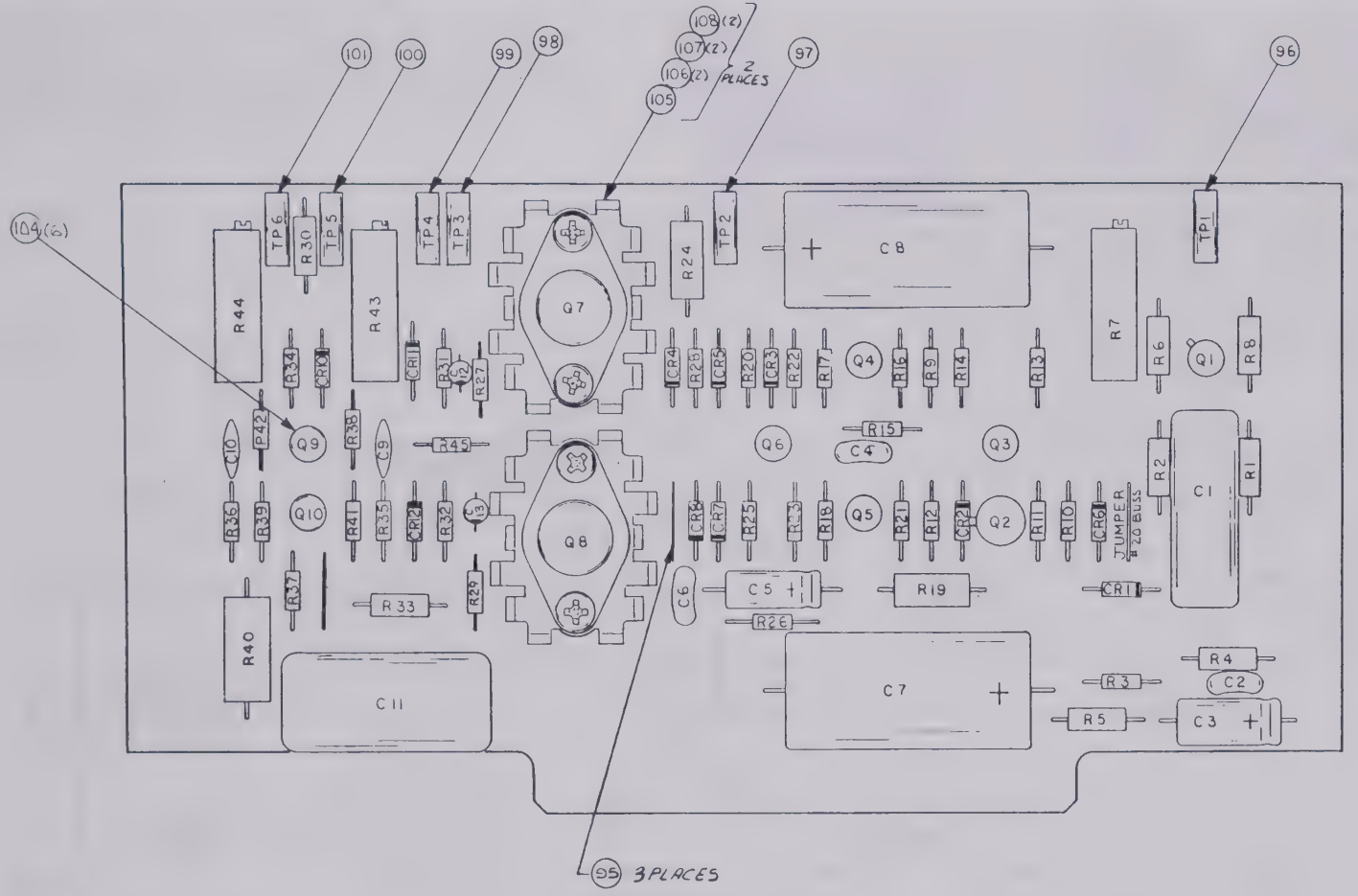
DWG NO D4025-071 REV H

SCALE NONE SHEET 1 OF 1

REV	DESCRIPTION OF CHANGE	APPD
C	INC EO 356	
D	ADDED NOTE 6	
E	INC EO 361	
F	INC EO 396 & 356	
G	INC EO 415	

3 2 1

C B A



FOR PARTS LIST SEE SHEETS 6 THRU 8.

3. APPLY ITEM 103 BETWEEN Q7, Q8 AND HEATSINK
2. MOUNT R19, R24 AND R40 1/8" OFF OF BOARD.
1. FOR SCHEMATIC DIAGRAM SEE DWG. *4025-071

NOTES:

DIM IN INCHES TOLERANCES XXX .010 XX .03 X .30	BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓	DWG SIZE C	TITLE PRE-AMP & DRIVER PC BD ASSEMBLY (A3)	CALICO CALIFORNIA INSTRUMENTS CORP SAN DIEGO CALIFORNIA
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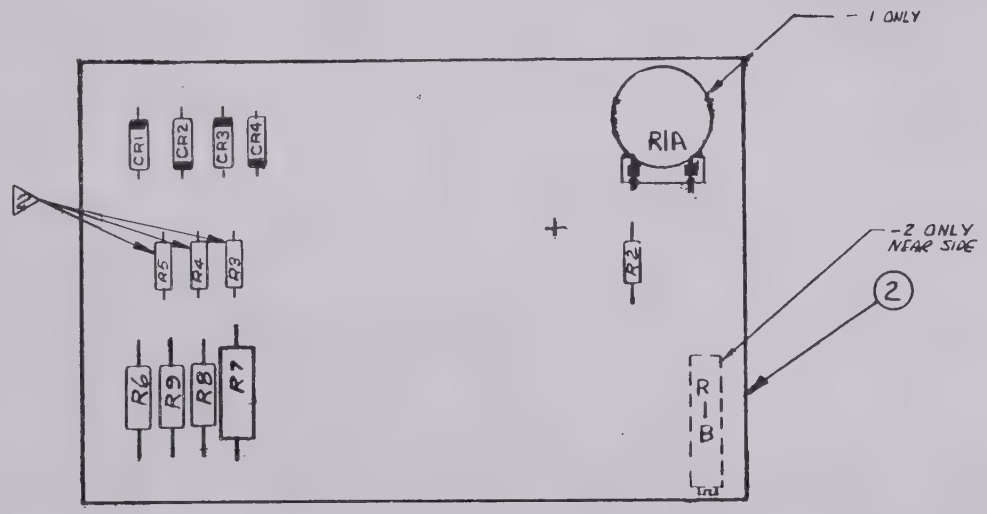
			RELEASE [illegible] PURCHASING	DWG NO 4025-704 REV A
			CHECKER [illegible] 7-7-65 PROJ ENGR	
			DESIGN CAWEED 7-7-65 CHF ENGR	SCALE 2:1 SHEET 2 OF 8
			DRFTSMN CAWEED	

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	04025-400		

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



A6

-1 ASSEMBLY

VIEWED FROM COMPONENT SIDE

C4050-702 C

PL 4050-702 PARTS LIST ON SHEET 4

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
-1								

DIM IN INCHES
TOLERANCES
.XXX = .010
.XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

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TITLE: VOLTMETER P.C. BOARD ASSY

MODEL: ALL A.C. POWER SOURCES (A6)

RELEASE	E. Davis	7/7/
CHECKER	[illegible]	7/15/
DESIGN		
DRFTSMN	S. Dane	7/7/
PURCHASING		
PROJ ENGR		
CHF ENGR		

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. C 4050-702 | REV D

SCALE 2/1 | SHEET 2 OF 4

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

CALICO F-188

④ MOUNT R3, R4, & R5 FAR SIDE.

1. FOR SCHEMATIC SEE DWG NO. B 4050-072

NOTES: (UNLESS OTHERWISE SPECIFIED)

B4050-072 A

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
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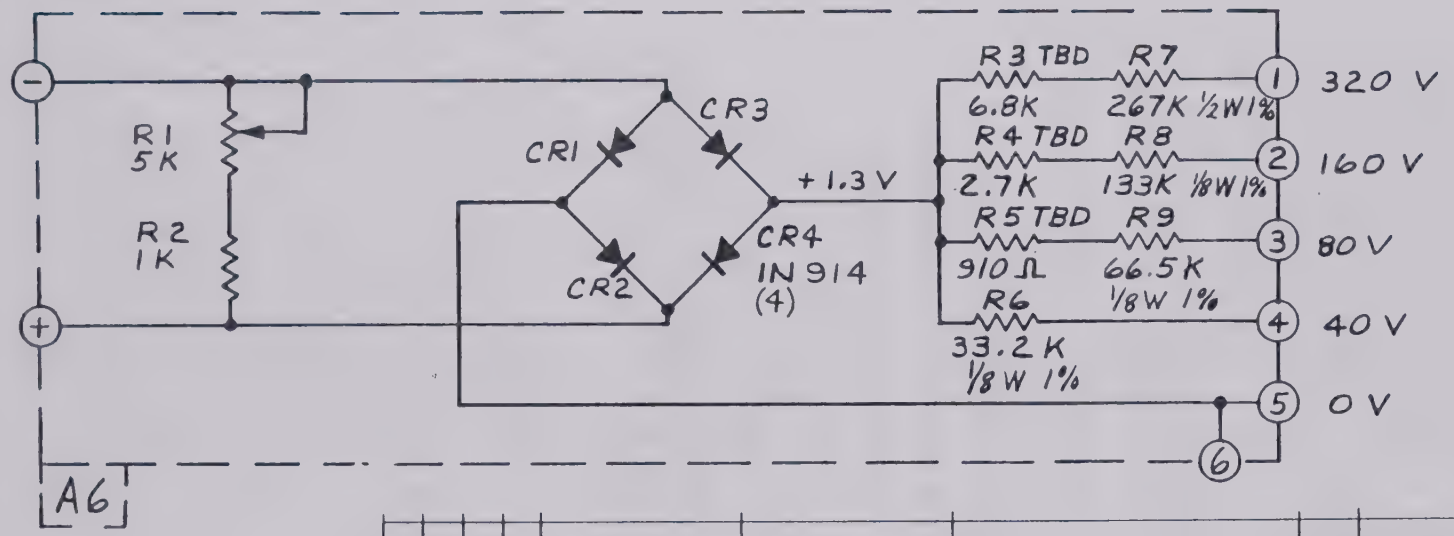

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

3. PREFIX "A6" TO BE USED WITH ALL REF DES. (EXAMPLE: A6R1)
2. FOR ASSY SEE D4050-702
1. ALL RESISTORS ARE ¼W 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES
TOLERANCES
.XXX = .010
.XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE B

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

TITLE
SCHEMATIC DIAGRAM VOLTMETER P.C. BD.

MODEL ALL "T" SERIES AC INVERTRONS

RELEASE	[illegible]	11/7/69		
CHECKER	[illegible]	7/15/69	PURCHASING	
DESIGN			PROJ ENGR	
DRFTSMN	D. Daniels	5/6/69	CHF ENGR	

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

DWG NO. B4050-072 REV A

SCALE NONE SHEET 1 OF 1

CALICO F 101

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident number (see Appendix A for list of manufacturers), and California Instruments' stock number are indicated.

7.2 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer's number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with California Instruments, Division of Amstar Technical Products Co., Inc., San Diego, California, 92111-1266.

7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "Seq. No." - Sequence number; the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alphanumerical order.

7.3.2 "Component Item No." - This is California Instruments part number. Please use this number when ordering spares.

7.3.3 "Description, Truncated" - A brief description of the item. Abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "Engineering Drawing No." - This is used for one of the following:

a) The document/specification number generated by California Instruments to control the part.

b) The generic part number (military specification or industry accepted standard).

c) The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown (contact California Instruments if the full number is required).

7.3.5 "Vendor" - This is the FSCM code identification (see Appendix A).

7.3.6 "Quan" and "U/M" - The requirements per unit of measure such as: "2 each"; "1 lb."; "4 oz."; or "6 SI" (square inches).

PARENT ITEM NO. 4025-400-1 | DESCRIPTION TOP ASSY,251T | ENGR DRAW 4025-400-1 |

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
	4025-050	HARNESS ASSY,JUMPER	4025-050	16067	1.0	EA
	4025-050-1	HARNESS ASSY	4025-050-1	16067	1.0	EA
	4025-050-2	HARNESS ASSY	4025-050-2	16067	1.0	EA
	4025-431-1	ENCLOSURE ASSY	4025-431-1	16067	1.0	EA
B1	241063	FAN,4",115VAC,50/60HZ	WS2107F-110	99743	1.0	EA
TB5	250050	TERMINAL STRP, 3TERM,2MT	3003	83330	1.0	EA
36	241078	PWR CORD,115V,14-3,6' W	14-3-SJT	0000A	1.0	EA
71	160022	ENCLOSURE	4025-201-7	16067	1.0	EA
87	210119	GROMMET,RUBBER,3/8"DIA	2170	83330	1.0	EA
94	210321	WASHER,INTER/EXTER #6	4006-14-00	78189	2.0	EA
117	250047	LUG,RING,SOLDER,#6	1416-6	83330	2.0	EA
	4025-432-1	CHASSIS ASSY	4025-432-1	16067	1.0	EA
CR1	310190	DIODE,RECT,(USE 310221)	1N1193	07716	1.0	EA
CR2	310190	DIODE,RECT,(USE 310221)	1N1193	07716	1.0	EA
CR3	310191	DIODE,RECT,(USE 310257)	1N1193R	07716	1.0	EA
CR4	310191	DIODE,RECT,(USE 310257)	1N1193R	07716	1.0	EA
C1	610672	CAP,AL,31,000UF,40V	36D313G040DC2B	56289	1.0	EA
C2	610672	CAP,AL,31,000UF,40V	36D313G040DC2B	56289	1.0	EA
C3	610084	CAP,MYLAR,.01UF,100V	1DP-1-103	72136	1.0	EA
R2	530068	RES,CARB,1W,47 OHM	RC32GF470J	81349	1.0	EA
R3	530068	RES,CARB,1W,47 OHM	RC32GF470J	81349	1.0	EA
R4	560202	RES,FILM,1/4W,1.82K,1%	RN60D1821F	81349	1.0	EA
R6	550120	RES,PWR,25W,.033 OHM,5%	RH-25-.033	91637	1.0	EA
R7	560017	RES,FILM,1/4W,681 OHM,1%	RN60D6810F	81349	1.0	EA
TB4	240111	TERMINAL STRP, 5TERM,2MT	3005	83330	1.0	EA
T2	710140	TRANSFORMER,CURR SENSE	4025-012-1	16067	1.0	EA
72	160023	CHASSIS	4025-202-7	16067	1.0	EA
73	160024	SUPPORT,CHASSIS	4025-203-7	16067	1.0	EA
79	160031	GUIDE,PWB	4025-210-7	16067	2.0	EA
82	110116	SPACER,POWER RES,RH-25	1360-217-8	16067	1.0	EA
83	210309	BUMPER,RUBBER	2193	08065	1.0	EA
86	241052	CAP CLAMP, 3"	4586-2	56289	2.0	EA
96	210155	INSULATOR,MICA,.25X.75	MW-750-255	08289	4.0	EA
97	210322	INSULATOR,SHLDR,NYL,1/4	#1/4 MOLDED NYL	23050	4.0	EA
100	210120	GROMMET,RUBBER,1/2"DIA	2175	83330	1.0	EA
117	250047	LUG,RING,SOLDER,#6	1416-6	83330	1.0	EA
124	210171	SCREW,PAN,S/S,6-32X1-1/4	MS51957-35	81349	1.0	EA
	4025-433-1	FRONT PANEL ASSY	4025-433-1	16067	1.0	EA
CB1	240318	CIRCUIT BREAKER,10A,250V	AM12-10-250-5-*	74193	1.0	EA
DS1	241021	LAMP,GAS,AMBER,120V	BG03ACSNE2H/33K	03797	1.0	EA
DS2	241022	LAMP,GAS,RED,120V	BG03RCSNE2H/33K	03797	1.0	EA
DS3	241122	LAMP,GAS,RED,120V	BG03WCSNE2H/33K	03797	1.0	EA
DS4	241021	LAMP,GAS,AMBER,120V	BG03ACSNE2H/33K	03797	1.0	EA
J4	240041	BINDING POST,RED	DF-31RC	58474	1.0	EA
J5	240090	BINDING POST,WHT	DF-31WTC	58474	1.0	EA
J6	240040	BINDING POST,BLK	DF-31BC	58474	1.0	EA
M1	CIC800	METER,DC,ANLG,MA,0-1	CIC800-0	16067	1.0	EA
M1	CIC800-1	METER W/4025-013	CIC800-1	16067	1.0	EA
R1	570128	POT,PNL,10K,1/2W,PREC	84010-012-1	16067	1.0	EA
R5	575052	POT,MT,PC,50 OHM,3/4W10%	78PR500	73138	1.0	EA
TB2	250093	TERMINAL STRP, 3TERM,1MT	864	83330	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
TB3	250097	TERMINAL STRP, STERM,1MT	866	83330	1.0	EA
70	160021-1	PANEL,FRONT W/4025-200	4025-200-1	16067	1.0	EA
75	160026	BRACKET,PLUG-IN,OSC	4025-205-7	16067	1.0	EA
84	241067	POT MOUNT KIT - MODEL 56	56BW	73138	1.0	EA
85	241124	GUIDE,PWB,4.15"	33-9016-12-01-≠	91662	2.0	EA
90	240225	HANDLE,FLT,S/S,4-9/16"	11519-S-0832-4	06540	2.0	EA
91	240233	KNOB,BLK	PS-70-2-BLK	21604	1.0	EA
	4025-434-1	REAR PANEL ASSY	4025-434-1	16067	1.0	EA
J3	410116	CONN,AC RCPT,3W,SIN,125V	5258	74545	1.0	EA
J7	240041	BINDING POST,RED	DF-31RC	58474	1.0	EA
J8	240090	BINDING POST,WHT	DF-31WTC	58474	1.0	EA
J9	240040	BINDING POST,BLK	DF-31BC	58474	1.0	EA
TB1	241123	TERMINAL BLK,12TERM, 5A	410-Y-12	75382	1.0	EA
78	160030	PANEL,REAR	4025-209-7	16067	1.0	EA
88	210106	GROMMET,RUBBER,9/16"DIA	2177,	83330	1.0	EA
118	250090	JUMPER,TERMINAL BLOCK	410J	75382	1.0	EA
119	210396	SCREW,RDH,S/S,4-40X1/2	4-40X1/2 ROUND	81349	4.0	EA
A1	4025-401-1	HEATSINK ASSY,OUT DRIVER	4025-401-1	16067	1.0	EA
A2	4025-401-2	HEATSINK ASSY,OUT DRIVER	4025-401-2	16067	1.0	EA
A3	4025-704-1	PC ASSY,PRE-AMPLIFIER	4025-704-1	16067	1.0	EA
A4	4025-402-1	PC ASSY,RANGE SWITCH	4025-402-1	16067	1.0	EA
A6	4050-702-1	PC ASSY,METER,VOLT	4050-702-1	16067	1.0	EA
T1	710138	TRANSFORMER,INPUT	4025-010-1	16067	1.0	EA
T3	710139	TRANSFORMER,OUTPUT	4025-011-1	16067	1.0	EA
74	160025	EAR,RACK MOUNTING	4025-204-7	16067	2.0	EA
76	160027	COVER,TOP & BOTTOM	4025-206-7	16067	2.0	EA
77	160029	WIND TUNNEL,HEATSINK	4025-208-7	16067	1.0	EA
80	130162	INSULATOR,HEATSINK	1060-215-7	16067	2.0	EA
95	FS3000	GROMMET,STRIP,.052	CSG-06-NATURAL	95987	6.0	IN
98	210091	NUT,SPEED,6-32	C8020-632	78553	18.0	EA
99	210266	INSULATOR,SHLDR,FBR,#4	SW-4-BLK	95987	8.0	EA
101	FS4007	RUBBER STRIP,ADHESIVE	1/2WIDEX1/8DEEP	81349	6.0	IN
102	210153	CABLE CLAMP,1/4"ID,NYLON	773	83330	1.0	EA
109	FS1008	SCREW,PNH,S/S,4-40X1/8	MS51957-11	81349	2.0	EA
110	FS1002	SCREW,PNH,S/S,4-40X9/16	MS51957-120	81349	8.0	EA
114	210152	SCREW,CTG,PNH,CAD,6X1/4	#6X1/4 TYPE B	45722	6.0	EA
115	FS1027	SCREW,FLH,S/S,6-32X1/4	MS24693-C24	81349	14.0	EA
116	FS1029	SCREW,FLH,S/S,6-32X3/8	MS24693-C26	81349	8.0	EA
120	FS1026	SCREW,PNH,S/S,6-32X1/4	MS51957-26	81349	4.0	EA
121	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	81349	17.0	EA
122	FS1032	SCREW,PNH,S/S,6-32X1/2	MS51957-30	81349	5.0	EA
123	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	81349	4.0	EA
125	FS3007	CABLE CLAMP,1/2"ID	CLE-1/2	51705	1.0	EA
126	FS1037	SCREW,PNH,S/S,6-32X7/8	MS51957-33	81349	4.0	EA
128	FS1044	SCREW,FLH,S/S,8-32X1/2	MS24693-C50	81349	6.0	EA
129	FS1045	SCREW,PNH,S/S,8-32X1/2	MS51957-45	81349	15.0	EA
132	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	14.0	EA
133	FS1069	WASHER,INTER,S/S,#6	MS35333-71	81349	43.0	EA
134	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	15.0	EA
135	FS1071	WASHER,INTER,S/S,#10	MS35333-73	81349	4.0	EA
136	FS1079	WASHER,FLAT,S/S,#4	MS15795-804	81349	8.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
137	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	81349	2.0	EA
138	FS1081	WASHER,FLAT,S/S,#8	MS15795-841	81349	9.0	EA
139	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	14.0	EA
140	FS1064	NUT,HEX,S/S,6-32	MS35649-264	81349	30.0	EA
141	FS1065	NUT,HEX,S/S,8-32	MS35649-284	81349	13.0	EA
142	FS1067	NUT,HEX,S/S,10-32	MS35650-304	81349	4.0	EA

PARENT ITEM NO. 4025-050-1 | DESCRIPTION HARNESS ASSY
ENGR DRAW 4025-050-1 |

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
J1	410032	CONN,PC EDGE,10 PIN	8BD10S-0	81312	1.0	EA
J2	410083	CONN,PC EDGE,22 PIN	8BD22S-0	81312	1.0	EA

PARENT ITEM NO. 4025-401-1 DESCRIPTION HEATSINK ASSY,OUT DRIVER ENGR DRAW 4025-401-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310190	DIODE,RECT,(USE 310221)	1N1193	07716	1.0	EA
Q1	330175	TRANSISTOR,PWR,NPN,TO3	2N4914	81349	1.0	EA
Q2	330236	TRANSISTOR,PWR,NPN,TO3*	2N5303	81349	1.0	EA
Q3	330236	TRANSISTOR,PWR,NPN,TO3*	2N5303	81349	1.0	EA
Q4	330236	TRANSISTOR,PWR,NPN,TO3*	2N5303	81349	1.0	EA
Q5	330236	TRANSISTOR,PWR,NPN,TO3*	2N5303	81349	1.0	EA
Q6	330236	TRANSISTOR,PWR,NPN,TO3*	2N5303	81349	1.0	EA
R1	520116	RES,CARB,1/2W,51 OHM	RC20GF510J	81349	1.0	EA
R2	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R3	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R4	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R5	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R6	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
4	160028	HEATSINK	4025-207-7	16067	1.0	EA
44	156045	PWB,HEATSINK,OUT DRIVER	4025-700-7	16067	1.0	EA
47	130145	STANDOFF,8-32 X 11/8"	1060-212-7	16067	2.0	EA
52	210205	INSULATOR,HEATSINK NO RE	4025-214-7	16067	2.0	EA
53	FS4001	THERMAL COMPOUND	THERMALCOTE	13103	.1	OZ
54	330192	INSULATOR,MICA,TO3	OM123	08289	1.0	EA
55	210153	CABLE CLAMP,1/4"ID,NYLON	773	83330	2.0	EA
56	FS5121	WIRE,BUS,MIL-W-3861 "S"	AWG 18	81349	.0	IN
57	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	81349	6.0	EA
58	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51597-13	81349	6.0	EA
59	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	81349	1.0	EA
60	FS1045	SCREW,PNH,S/S,8-32X1/2	MS51957-45	81349	2.0	EA
61	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	81349	2.0	EA
62	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	81349	1.0	EA
63	FS1074	WASHER,SPLT,S/S,#8	MS35338-137	81349	2.0	EA
64	210110	INSULATOR,SHLDR,NYL,#8	2665	83330	2.0	EA
65	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	81349	1.0	EA
67	FS1076	WASHER,EXTER,S/S,#4	MS35335-57	81349	.0	EA
69	FS1064	NUT,HEX,S/S,6-32	MS35649-264	81349	1.0	EA
70	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	6.0	EA

PARENT ITEM NO. 4025-401-2 DESCRIPTION HEATSINK ASSY,OUT DRIVER ENGR DRAW 4025-401-2

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310190	DIODE,RECT,(USE 310221)	1N1193	07716	1.0	EA
C1	610084	CAP,MYLAR,.01UF,100V	1DP-1-103	72136	1.0	EA
Q1	330157	TRANSISTOR,PWR,PNP,TO3	2N4905	04713	1.0	EA
Q2	330236	TRANSISTOR,PWR,NPN,TO3≑	2N5303	81349	1.0	EA
Q3	330236	TRANSISTOR,PWR,NPN,TO3≑	2N5303	81349	1.0	EA
Q4	330236	TRANSISTOR,PWR,NPN,TO3≑	2N5303	81349	1.0	EA
Q5	330236	TRANSISTOR,PWR,NPN,TO3≑	2N5303	81349	1.0	EA
Q6	330236	TRANSISTOR,PWR,NPN,TO3≑	2N5303	81349	1.0	EA
R1	520116	RES,CARB,1/2W,51 OHM	RC20GF510J	81349	1.0	EA
R2	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R3	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R4	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R5	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R6	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R7	520013	RES,CARB,1/2W,47 OHM	RC20GF470J	81349	1.0	EA
4	160028	HEATSINK	4025-207-7	16067	1.0	EA
44	156045	PWB,HEATSINK,OUT DRIVER	4025-700-7	16067	1.0	EA
47	130145	STANDOFF,8-32 X 11/8"	1060-212-7	16067	2.0	EA
52	210205	INSULATOR,HEATSINK NO RE	4025-214-7	16067	2.0	EA
53	FS4001	THERMAL COMPOUND	THERMALCOTE	13103	.1	OZ
54	330192	INSULATOR,MICA,TO3	DM123	08289	1.0	EA
55	210153	CABLE CLAMP,1/4"ID,NYLON	773	83330	2.0	EA
56	FS5121	WIRE,BUS,MIL-W-3861 "S"	AWG 18	81349	1.0	IN
57	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	81349	6.0	EA
58	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51597-13	81349	6.0	EA
59	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	81349	1.0	EA
60	FS1045	SCREW,PNH,S/S,8-32X1/2	MS51957-45	81349	2.0	EA
61	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	81349	1.0	EA
62	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	81349	1.0	EA
63	FS1074	WASHER,SPLT,S/S,#8	MS35338-137	81349	2.0	EA
64	210110	INSULATOR,SHLDR,NYL,#8	2665	83330	2.0	EA
65	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	81349	1.0	EA
66	210076	INSULATOR,SHLDR,NYL,#4	NY04-040	08289	1.0	EA
67	FS1076	WASHER,EXTER,S/S,#4	MS35335-57	81349	12.0	EA
69	FS1064	NUT,HEX,S/S,6-32	MS35649-264	81349	1.0	EA
70	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	6.0	EA

PARENT ITEM NO. 4025-704-1 | DESCRIPTION PC ASSY,PREAMP
ENGR DRAW 4025-704-1 |

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310169	DIODE,ZNR,10V,.5W,5%	1N5240B	04713	1.0	EA
CR2	310129	DIODE,ZNR,3.3V,.5W,5%	1N5226B	04713	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR5	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR6	310169	DIODE,ZNR,10V,.5W,5%	1N5240B	04713	1.0	EA
CR7	310172	DIODE,RECT,(USE 310062)	1N4001	04713	1.0	EA
CR8	310172	DIODE,RECT,(USE 310062)	1N4001	04713	1.0	EA
CR10	310172	DIODE,RECT,(USE 310062)	1N4001	04713	1.0	EA
CR11	310172	DIODE,RECT,(USE 310062)	1N4001	04713	1.0	EA
CR12	310172	DIODE,RECT,(USE 310062)	1N4001	04713	1.0	EA
C1	610566	CAP,MYLAR,.22UF,100V	1DP-3-224	72136	1.0	EA
C2	610018	CAP,MICA,62PF,500V	CM05E620J03	81349	1.0	EA
C3	610353	CAP,AL,25UF,12V	TE1131	56289	1.0	EA
C4	610673	CAP,MICA,510PF,500V	DM15-551J	72136	1.0	EA
C5	610331	CAP,AL,5UF,50V	TE1303	56289	1.0	EA
C6	610282	CAP,MICA,200PF,500V	CM05F201J03	81349	1.0	EA
C7	610395	CAP,AL,250UF,50V	WBR250-50	14655	1.0	EA
C8	610395	CAP,AL,250UF,50V	WBR250-50	14655	1.0	EA
C9	610131	CAP,MYLAR,.1UF,100V	1DP-2-104	72136	1.0	EA
C10	610131	CAP,MYLAR,.1UF,100V	1DP-2-104	72136	1.0	EA
C11	610577	CAP,MYLAR,.47UF,100V	1DP-4-474	72136	1.0	EA
C12	610761	CAP,TANT,1UF,20V	T362A105M020AS	05397	1.0	EA
C13	610761	CAP,TANT,1UF,20V	T362A105M020AS	05397	1.0	EA
Q1	330293	TRANSISTOR,FET,N,DUAL	IT502	32293	1.0	EA
Q2	330012	TRANSISTOR,SS,NPN,DUAL	CIC333	16067	1.0	EA
Q3	330008	TRANSISTOR,SS,NPN,TO18	CIC330	16067	1.0	EA
Q4	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q5	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q6	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q7	330102	TRANSISTOR,PWR,PNP,TO66	2N3741	81349	1.0	EA
Q8	330103	TRANSISTOR,PWR,NPN,TO66	2N3767	81349	1.0	EA
Q9	330008	TRANSISTOR,SS,NPN,TO18	CIC330	16067	1.0	EA
Q10	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
R1	560340	RES,FILM,1/4W,147K,1%	RN60C1473F	81349	1.0	EA
R2	560239	RES,FILM,1/4W,20K,1%	RN60C2002F	81349	1.0	EA
R3	510066	RES,CARB,1/4W,3.9K OHM	RC07GF392J	81349	1.0	EA
R4	560239	RES,FILM,1/4W,20K,1%	RN60C2002F	81349	1.0	EA
R5	560342	RES,FILM,1/4W,1K,1%	RN60C1001F	81349	1.0	EA
R6	560114	RES,FILM,1/4W,49.9K,1%	RN60C4992F	81349	1.0	EA
R7	575051	POT,MT,PC,20K,1/2W,10%	2317-203	91637	1.0	EA
R8	560114	RES,FILM,1/4W,49.9K,1%	RN60C4992F	81349	1.0	EA
R9	510071	RES,CARB,1/4W,6.2K OHM	RC07GF622J	81349	1.0	EA
R10	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R11	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R12	510066	RES,CARB,1/4W,3.9K OHM	RC07GF392J	81349	1.0	EA
R13	510055	RES,CARB,1/4W,1.2K OHM	RC07GF122J	81349	1.0	EA
R14	510061	RES,CARB,1/4W,2.4K OHM	RC07GF242J	81349	1.0	EA
R15	510057	RES,CARB,1/4W,1.5K OHM	RC07GF152J	81349	1.0	EA
R16	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R17	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
R18	510041	RES,CARB,1/4W,330 OHM	RC07GF331J	81349	1.0	EA
R19	550156	RES,PWR,3-1/4W,400 OHM5%	4408	44655	1.0	EA
R20	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R21	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R22	510046	RES,CARB,1/4W,510 OHM	RC07GF511J	81349	1.0	EA
R23	510075	RES,CARB,1/4W,9.1K OHM	RC07GF912J	81349	1.0	EA
R24	550157	RES,PWR,3-1/4W,500 OHM	4411	44655	1.0	EA
R25	510066	RES,CARB,1/4W,3.9K OHM	RC07GF392J	81349	1.0	EA
R26	510078	RES,CARB,1/4W,12K OHM	RC07GF123J	81349	1.0	EA
R27	510013	RES,CARB,1/4W,22 OHM	RC07GF220J	81349	1.0	EA
R28	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R29	510013	RES,CARB,1/4W,22 OHM	RC07GF220J	81349	1.0	EA
R30	520006	RES,CARB,1/2W,10.0 OHM	RC20GF100J	81349	1.0	EA
R31	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R32	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R33	520011	RES,CARB,1/2W,33 OHM	RC20GF330J	81349	1.0	EA
R34	510074	RES,CARB,1/4W,8.2K OHM	RC07GF822J	81349	1.0	EA
R35	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R36	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R37	510074	RES,CARB,1/4W,8.2K OHM	RC07GF822J	81349	1.0	EA
R38	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R39	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R40	540001	RES,CARB,2W,1 OHM	BWH 1 OHM	07716	1.0	EA
R41	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R42	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R43	575050	POT,MT,PC,50 OHM,1/2W10%	2317-500	91637	1.0	EA
R44	575050	POT,MT,PC,50 OHM,1/2W10%	2317-500	91637	1.0	EA
R45	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
TP1	241089	TEST JACK,PC,DBL ENT,BRN	430-108	83330	1.0	EA
TP2	241085	TEST JACK,PC,DBL ENT,RED	430-102	83330	1.0	EA
TP3	241086	TEST JACK,PC,DBL ENT,ORN	430-106	83330	1.0	EA
TP4	241087	TEST JACK,PC,DBL ENT,YEL	430-107	83330	1.0	EA
TP5	241090	TEST JACK,PC,DBL ENT,GRN	430-104	83330	1.0	EC
TP6	241091	TEST JACK,DBL ENT,BLU	430-105	83330	1.0	EA
2	156043	PWB,PRE-AMPLIFIER	4025-704-7	16067	1.0	EA
103	FS4001	THERMAL COMPOUND	THERMALCOTE	13103	.1	OZ
104	240297	SOCKET,XSTR,TO-18	RCT018110-1A	19080	6.0	EA
105	241047	HEATSINK,TO66	L8668118	98978	2.0	EA
106	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	81349	4.0	EA
107	FS1069	WASHER,INTER,S/S,#6	MS35333-71	81349	4.0	EA
108	FS1064	NUT,HEX,S/S,6-32	MS35649-264	81349	4.0	EA

PARENT ITEM NO. 4025-402-1

DESCRIPTION PC ASSY,RANGE SWITCH
ENGR DRAW 4025-402-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
C1	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
C2	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
C3	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
C4	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
C5	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
C6	610572	CAP,MYLAR,.047UF,100V	225P47391	56289	1.0	EA
R1	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R2	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R3	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R4	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R5	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R6	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
S1	240420	SWITCH,RTRY,4P 3P/3DECK	4025-014-1	16067	1.0	ST
3	156044	PWB,SET,RANGE SWITCH	4025-701-7-8-9	16067	1.0	ST
29	210087	INSULATOR,FLAT,FBR,#4	2161	83330	3.0	EA
31	FS5121	WIRE,BUS,MIL-W-3861 "S"	AWG 18	81349	.0	IN

PARENT ITEM NO. 4050-702-1

DESCRIPTION PC ASSY,METER,VOLT
ENGR DRAW 4050-702-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310118	DIODE,SWNG,75V,.5W,0035	1N914	07263	1.0	EA
CR2	310118	DIODE,SWNG,75V,.5W,0035	1N914	07263	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,0035	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,0035	1N914	07263	1.0	EA
R1	575036	POT,1T,PC,5K,1/4W	U201R502B	71450	1.0	EA
R2	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R3	510072	RES,CARB,1/4W,6.8K OHM	RC07GF682J	81349	1.0	EA
R4	510062	RES,CARB,1/4W,2.7K OHM	RC07GF272J	81349	1.0	EA
R5	510052	RES,CARB,1/4W,910 OHM	RC07GF911J	81349	1.0	EA
R6	560249	RES,FILM,1/4W,33.2K,1%	RN60C3322F	81349	1.0	EA
R7	560330	RES,FILM,3/4W,267K,1%	RN70C2673F	81349	1.0	EA
R8	560329	RES,FILM,1/4W,133K,1%	RN60C1333F	81349	1.0	EA
R9	560399	RES,FILM,1/4W,66.5K,1%	RN60C6652F	81349	1.0	EA
2	157003	PWB,METER,VOLT	4050-702-7	16067	1.0	EA

Appendix A

Code	Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon, Surrey	GB
0000S	CPCDA	Edison	NJ
0000W	Milton Ross Co.	Southampton	PA
0000Z	Timco	Los Angeles	CA
000AC	ITAC	Santa Clara	CA
000AD	Plessey	Westlake Village	CA
000AG	La France	Philadelphia	PA
000AH	Jan Crystal	Ft. Myers	CA
000AL	Data Components, Inc.	Santa Monica	CA
000AM	Kraus & Naimer	Santa Monica	CA
000AN	Ritz Instrument Transformer Co.	Redondo Beach	CA
000AS	Switches Incorporated	Mt. View	CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electric Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	Jann St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Products Dept.	Waterford	NY
01295	Texas Instruments	Dallas	TX
02111	Spectrol Electronics	City of Industry	CA
02335	Fairchild Controls Corp.	Hicksville, LI	NY
02375	American Insulating Machinery Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02799	Use Code #72136		
02507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford	CT
04713	Motorola Semiconductor Prod., Inc.	Phoenix	AZ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics Co., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05820	Wakefield Engineering, Inc.	Wakefield	MA
06383	Panduit Corp.	Tinley Park	IL
06514	Stantron, Wyco Metal Products	N. Hollywood	CA
06540	Amathom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera and Instr. Corp.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Unitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07716	IRC Incorporated	Burrington	IA
08065	Accurate Rubber and Plastics Co.	San Diego	CA
08261	Spectra Strip	Garden Grove	CA
08289	Blinn-Delbert Co., Inc.	Pomona	CA
08353	Bristol Co.	Toronto	CANADA
08524	Deutsch Fastener Corp.	Los Angeles	CA
08730	Vemaline Products Co.	Franklin Lakes	NJ
08779	Signal Transformer Co.	Brooklyn	NY
09353	C and K Components	Newton	MA
10389	Chicago Switch Inc.	Chicago	IL
11815	Cherry Rivet Div., Townsend Co.	Santa Ana	CA
12406	Elpac, Incorporated	Fullerton	CA
12697	Clarostat Mfg. Co., Incorporated	Dover	NH
13103	Thermalloy Company	Dallas	TX
14099	Semtech Corporation	Newbury Park	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Incorporated	San Gabriel	CA
15238	ITT Semiconductors	Lawrence	MA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelco Teledyne, Incorporated	Mt. View	CA
15912	Ansley	Los Angeles	CA
16067	California Instruments Company	San Diego	CA
16758	Delco Radio Div., General Motors	Kokomo	IN
16956	Dennison	Framingham	MS
18076	Umpco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	Mo
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments Inc.	Malvern	PA
18677	Scambe Mfg. Co.	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	The Robinson Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
22599	Elastic Stop Nut Corporation	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pamotor, Incorporated	San Francisco	CA
24011	ECC	Burlington	MA
24444	General Semiconductor Industries Inc.	Tempe	AZ
24796	Parelco Inc.	Paramount	CA
25497	Meter Master	Los Angeles	CA
26806	American Zettler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Varo, Incorporated	Ft. Garland	TX
27832	Hughes Aircraft	Newport Beach	CA

Code	Name	City	State
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
30039	International Components Corp.	Asbury Park	NJ
30983	Electra/Midland (Mepco/Electra)	San Diego	CA
30161	David Engineering Inc.	Laconia	NH
30897	Dorann Company	Sylmar	CA
31931	Trimcode Inc.	Pittsburgh	PA
32293	Intersil	Cupertino	CA
32559	Bivar, Inc.	Santa Ana	CA
33005	Jewell Electrical Instruments Inc.	Manchester	NH
33716	Kingsbacher Murray Co.	Los Angeles	CA
33855	Ducommun Inc.	Los Angeles	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
44655	Ohmite Manufacturing Company	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50522	Monsanto, Electronic Special Products	Cupertino	CA
51167	Aries Electronics Inc.	Frenchtown	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembl. Corp.	Costa Mesa	CA
54407	Power-One Co.	Camarillo	CA
56289	Sprague Electric Company	North Adams	MA
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union, Inc.	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	TRW Cinch	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Products Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73734	Federal Screw Products, Inc.	Chicago	IL
74197	Heinemann Electric Company	Trenton	NJ
75042	[illegible] Inc.	Bridgeport	CT
75090	[illegible] Co.	Chicago	IL
75170	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	[illegible] Corporation	Mt. Vernon	NY
75915	Littlefuse Inc. Incorporated	Des Plaines	IL
76152	Amphenol-Borg Elec., Pathwin Division	Waterbury	CT
76162	Bussman Mfg. Div., McGraw-Edison Co., AMF	E. Princeton	IN
76189	Shakeproof Div., Illinois Tool Works	Chicago	IL
76854	Pioneer-Standard Products, Inc.	Cleveland	OH
76870	Semiconductor Products Corp.	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corporation	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Incorporated	Riverside	CA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81349	Military Specification or Commercial Generic Number		
81603	Raco Products Co.	Chicago	IL
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Incorporated	Chicago	IL
82877	Rotron Manufacturing Co., Inc.	Woodstock	NY
82893	Vector Electronics Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool and Screw Corp.	Rockford	IL
86684	RCA	Harrison	NJ
87034	Marco-Oak Industries	Anaheim	CA
88245	Useco Div., Litton Industries	Van Nuys	CA
90201	Mallory Capacitor Company	Indianapolis	IN
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91833	Keystone Electronics Corp.	New York	NY
92194	Alpha Wire Corporation	Elizabeth	NJ
94222	Southco, Incorporated	Lester	PA
95303	RCA	Cincinnati	OH
95987	Weckesser Company, Inc.	Chicago	IL
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Teck, Incorporated	Gardena	CA
98291	Sealecto Corp.	Mamaroneck	NY
98376	Zero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99743	IMC	Maywood	CA
99800	Delevan Electronics Corporation	Aurora	NY

Revision J
January 5, 1982

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Amstar Technical Products Co., Inc., warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

MP MASTER
MA26630